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HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY

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BATTELLE COLUMBUS LABORATORIES, OHIO

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HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY

Mechanical, Thermal, Electrical, and Magnetic Properties of Structural Materials Including Data Sheets for the First and Second Supplements

Includes Data Sheets for First and Second Supplements

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Thermal conductivity	Magnetic Properties	Alloy steels	Polymers
		Composite Materials	Weldments

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The major objective of this second supplement, as for the first supplement and the Handbook, is to present data that could be used effectively in the development of new concepts in superconducting machinery. Information was collected on the mechanical, thermal, electrical, and magnetic properties of selected structural materials and welds for designers and users of equipment that will be exposed to cryogenic temperatures. The data are presented as "best-value" numbers from compilations of data in the temperature range 0 to 300 K.

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Materials for inclusion in this Handbook include the following'

Aluminum and aluminum alloys
Copper and copper alloys
Nickel alloys
Alloy steels
Stainless steels
Titanium and titanium alloys
Special metal and alloys
Polymers
Composite materials
Weldments.

SECOND SUPPLEMENT

to

HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY – FIRST EDITION MCIC-HB-04

The original Handbook was prepared by Battelle's Columbus Laboratories under Advanced Research Projects Agency (ARPA) sponsorship, monitored by the Cryogenics Division of the National Bureau of Standards, and published by the Metals and Ceramics Information Center (MCIC). This second supplement was prepared under the same sponsorship to update the information in the initial publication.

This supplement, as does the original handbook, contains information on the mechanical, thermal, electrical, and magnetic properties of selected structural materials that might be considered for components of superconducting machinery. Since this information is primarily intended for designers of equipment that will be exposed to cryogenic temperatures, the data are presented as "best-value" numbers from compilations of data in the temperature range 0 to 300 K.

This second supplement contains a new title page, a Foreword to the Second Supplement, an updated Table of Contents, new sheets for Sections 1 through 12, a new list of references, and new Bibliography pages.

INSERTING THE NEW DATA SHEETS IN THE HANDBOOK–

The procedure for inserting the new data sheets in the Handbook is as follows:

Section 1.0	Replace the single page in this section
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Section 11.0	This is a new section on Composites; the new divider and the new data sheets should be added, (29 pages, 17 sheets)
Section 12.0	Replace or insert the indicated 18 pages (11 sheets)
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The enclosed descriptive sticker is for the front of the binder just below the date.

KEEPING YOUR HANDBOOK UP TO DATE–

So that we may continue to keep all holders of the Handbook on Materials for Superconducting Machinery advised of supplements and new reference data, a registry of the locations of all copies is being maintained. To assist us in keeping these records, we ask that you complete and return one of the following self-addressed postcards upon initial receipt of this Supplement. If responsibility of this copy of the Handbook is transferred to another party, please use one of the postcards to advise us of the change. (Please indicate that the previous card should be removed from our records). If there are no postcards available, please write to MCIC at the address below.

ADDITIONAL INFORMATION–

Any questions on the Handbook data or request for additional data should be addressed to the attention of Mr. Harold J. Hucek, Manager of Publications at:

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FOREWORD

The research program that has led to the preparation of this Handbook was supported by the Advanced Research Projects Agency (ARPA) of the Department of Defense, with Dr. Edward C. Van Reuth as Project Monitor. The Handbook preparation task was subcontracted to Battelle Columbus by the Cryogenics Division of the National Bureau of Standards under Contract No.CST-8303 with Dr. Richard P. Reed as Program Manager and Contract Monitor.

The research program was conducted under ARPA Order No. 2569 and Program Code 4D10 by the Metals and Ceramics Information Center (MCIC) with K. R. Hanby and H. J. Hucek as Program Managers, and E. A. Eldridge and J. K. Thompson as Principal Investigators.

Contract No. CST-8303 includes two tasks. Task I provided for the compilation of low temperature property data on selected materials for structural applications in superconducting machinery and has resulted in the production of this Handbook. Task II provided for research on the thermal expansion and specific heats at low temperatures for selected structural alloys. Available data obtained on Task II are incorporated in this edition of the Handbook. Additional data from other concurrent ARPA/NBS programs are included in the First and Second Revisions. The effective date for initiation of the program was September 10, 1973, and the contract expiration date was January 15, 1977.

DISCLAIMER

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or of the U. S. Government.

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HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY

1.0 INTRODUCTION

Recent advancements in the development of superconducting machinery have demonstrated that superconducting generators, motors, transmission lines, and other electrical equipment are more efficient, occupy less space for equivalent capacity, and have other advantages over more conventional equipment. Because of these advantages, there is considerable incentive to develop superconducting systems for certain military applications. New ship propulsion systems which are being developed by the Navy represent major developments in superconducting generators, motors, and controls. These developments involve considerable new design technology and environments that may expose the components to cryogenic temperatures as low as 4 K. Exposure of structural materials to such low temperatures affects the mechanical and physical properties of the materials. The purpose of the Handbook is to provide a ready reference for designers on the effects of low temperatures on the properties of structural materials that will be considered in developing new designs for superconducting machinery. Formats for presentation of the mechanical, thermal, electrical, and magnetic property data are intended to provide best-value data for the designer based on currently available information. The data also may be used by engineers in selecting materials for certain cryogenic applications. The current list of materials was selected based on available information and suitability for such applications. All data are based on current state-of-the-art information.

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2.0 EXPLANATION OF DATA COLLECTION AND PRESENTATION

The structural materials property data presented in this Handbook are based on compilations of data collected from documents in the files of the Metals and Ceramics Information Center (MCIC). These documents either were originally part of the data base of MCIC or were acquired as a result of a search of the accessions of the Cryogenic Data Center, Cryogenics Division, National Bureau of Standards, Boulder, Colorado. Documents from which the data were obtained are listed in the Reference section according to MCIC accession number. The Bibliography, which includes cited data references, lists over 900 citations on properties and applications of the selected materials. The 18 references for the composite materials are listed at the end of Section 11, Composites. When more detailed information is needed than the best-value data presented in later sections of this Handbook, the original sources of the data should be consulted.

Data from the original sources were collected on the selected materials (discussed in Section 3) within the following categories over the temperature range 0 to 300 K:

(a) Mechanical properties (Includes weld properties)

(b) Thermal properties

Thermal conductivity*

Thermal expansion

Specific Heat

(c) Electrical resistivity

(d) Magnetoresistance

(e) Magnetic properties.

2.1 Mechanical Properties

After compiling the available mechanical property data from the original sources, the major objective was to reduce the data on metals, welds, composites, and polymers to best values and to present the best-value data in formats that could be used effectively by designers in developing new concepts in superconducting machinery. In general, the available data for any of the parameters was not sufficient for any material in the cryogenic range to permit a statistical analysis to yield A or B basis (minimum design) values as in MIL-HDBK-5. However, judgment was used in analyzing the available data in order to arrive at best-value numbers for the various parameters based on the available data. The best-value numbers are averages obtained usually from a series of tests from one or more sources on individual specimens. From some sources, only average data and not individual specimen data were available for the mechanical property parameters. If information was available on the number of specimens tested in obtaining the original average value, the number of specimens was taken into consideration in arriving at the overall average or best value. If information was not available on the number of specimens tested in arriving at an original average value, the average value reported was considered the same as that for a single specimen in calculating the overall average. If tensile ultimate strength or tensile yield strength data were available for eight or more replicate specimens, standard deviations were determined and are included in the tabulations. If the original input data include average values, the results will not be true standard deviations, but will be the best that can be determined from the available sources.

* Data include the effects of magnetic fields on thermal conductivity.

Data that were not representative of normally produced material (i.e., material with unusual impurity levels, unusual grain sizes, etc.) were not included in the compilations. Furthermore, if the heat treatment, form, or dimensions (thickness, diameter, etc.) of the material were not given or if specimen orientation or other significant information on the specimens or test methods was not given in the original source, the data were omitted from the compilations. When data points occurred outside the range of the usual scatter of data points (outriders), the original source was reviewed to determine any unusual factors that would contribute to the variation. Such an examination usually provided a basis for omitting the outriding points.

Typical formats for compiling best values for mechanical property parameters for metals, alloys, and polymers are shown in Tables 2.1, 2.2, and 2.3. The same formats were used to report weld data when it was available. The parameters in Table 2.1 are for tensile properties. Most of the available mechanical property data at cryogenic temperatures is limited to tensile data. When compressive, shear, impact, fracture toughness, and/or fatigue data were available for any of the materials, the corresponding formats in Tables 2.2 and/or 2.3 were used in recording the best-value data.

Typical formats for compiling best values for mechanical properties of composite materials are shown in Tables 2.4, 2.5, and 2.6. Data are reported for uniaxial laminates and for woven-cloth reinforced composites. Uniaxial laminate data include key mechanical properties required for prediction of crossply properties using macromechanical composite theory, whenever such data were available.

The highly-anisotropic mechanical properties of composite materials require referencing of the properties to the direction of fiber reinforcement. Tensile, compressive and impact data, Tables 2.4 and 2.5, are reported for longitudinal and transverse directions of uniaxial composites. The sheet-normal direction is included in the compressive data format. This refers to loading directions parallel to and at right angles to the fiber direction, plus a direction normal to the plane of pressing in sheet material (press-cure direction). For composites reinforced with woven cloth, the longitudinal direction is taken as the warp direction and the transverse direction is taken as the fill direction. Crossply composites frequently display an initial and secondary modulus during the initial load cycle; consequently, both moduli and the strength corresponding to the change in modulus are reported when data were available. Most composite data are reported as average and minimum reported values. However, compressive strength data are reported as maximum, average, and minimum values. Here, the maximum value is the most significant, as the average of compressive strength data tends to become strongly biased toward low values due to experimental difficulties.

Composite interlaminar shear refers to shear between adjacent layers in a layered laminate. Composite in-plane shear refers to shear between parallel fibers in the plane of the fibers.

Available composite fatigue data are presented graphically in the format shown in Table 2.6. In many applications, the useful fatigue life of composite structures will be limited by a decrease in modulus rather than ultimate fracture. The format of Table 2.6 permits data on modulus decrement to be included when available.

Data on Tables 2.4, 2.5, and 2.6 reflect best values from flat coupons, rods or bulk specimens produced from preimpregnated tape except where noted. References are provided for each value to facilitate consulation of the original source for additional information on test procedures.

It is possible to fabricate composites with widely varying fiber volume fractions and widely varying properties. Most available data have been generated for the nominal fiber volume fractions reported in the tables, corresponding to the fiber content in off-the-shelf preimpregnated materials.

In most instances, the property data were added to the original compilation tables only when such data were reported for tests at 77 K (-320 F) or lower. When test data were reported for tests at 77 K or lower, all of the test data in the range 0 to 300 K were added to the original compilation tables. This method of selecting the data eliminated much of the data that would not be significant when considering cryogenic properties.

The headings in the tables indicate the alloy, welding method, polymer, or composite designation from the list presented in Section 3. If a specification was identified for the material, the specification is identified in the heading. For metals and alloys and welds, thicknesses or diameters of the material in the form identified are given in the heading for limited ranges, since the size may have a significant effect on the properties. The size ranges are as follows:

Sheet, Plate, and Flat Forgings and Extrusions (Thickness):

Up to 0.099 cm (0.039 in.)
0.100 to 0.319 cm (0.040 to 0.125 in.)
0.320 to 0.634 cm (0.126 to 0.249 in.)
0.635 to 1.269 cm (0.250 to 0.499 in.)
1.270 to 2.540 cm (0.500 to 1.000 in.)
2.541 to 5.080 cm (1.001 to 2.000 in.)
Over 5.080 cm (2.000 in.)

Bar Stock, Forged Stock, and Non-Flat Extrusions
(Diameter or Thickness):

Up to 2.540 cm (1.000 in.)
2.541 to 5.080 cm (1.001 to 2.000 in.)
Over 5.080 cm (2.000 in.)

Data for the same alloy type and thickness range may be available for several different heat treatments and/or mill processing conditions. Data for the alloy are presented for these various conditions if they might be considered for components which will be exposed to low temperatures in service.

The first column in the mechanical property tables indicates the parameters and units. Bold face type is used for the parameters and best-value numbers (indicated as "Avg") so they will stand out from the other numbers. The next column in the tables is for room temperature data which usually are obtained in the range 291 to 300 K (65 to 80 F). The heading for this column is 297 K (75 F). Another key temperature range for low temperature mechanical property tests is obtained by cooling an organic liquid with dry ice. Indicated temperatures for this type of low-temperature bath are 200 to 193 K (-100 to -112 F). To simplify the tabulations, tests made in dry-ice baths are indicated at 195 K (-108 F). Tests made with the specimens in liquid nitrogen, liquid hydrogen, and liquid helium are indicated at 77 K (-320 F), 20 K (-423 F), and 4 K (-452 F), respectively. For test data obtained at intermediate temperatures such as 144 K (-200 F), the data are presented in separate columns with the testing temperature indicated in the column heading.

The primary units in the tables are SI units with corresponding English units in parentheses. Values for stress and energy in SI units were generally converted from English units. In most instances, the average values in English units were not rounded off until after converting to the SI units. The English units were then rounded off usually to three digits for presentation in the tables. Because the English units were rounded off after conversion, conversion of the three-digit numbers will not always result in the corresponding converted SI units in the tables.

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Abbreviations used in the mechanical property tables have the following meanings:

TUS	- Tensile ultimate strength
TPL	- Tensile proportional limit
TYS	- Tensile yield strength
Elong.	- Elongation
RA	- Reduction in area
E	- Young's modulus
E_1	- Initial Young's modulus (composites)
E_2	- Secondary Young's modulus (composites)
SE_1	- Strength at transition between E_1 and E_2
NTS	- Notched tensile strength
CUS	- Compressive ultimate strength
CPL	- Compressive proportional limit
E_c	- Elastic modulus in compression
SUS	- Shear ultimate strength
SPL	- Shear proportional limit
G	- Shear modulus
Long.	- Longitudinal orientation
Trans.	- Transverse orientation
K_{Ic}	- Plane strain intensity factor obtained on precracked bend or compact specimens according to ASTM E399
K_{IE}	- Plane strain stress intensity factor obtained on part-through surface-crack specimens (requirements for validity of these tests have not been established, but selected data are included in the compilations to indicate the trends in the results that have been obtained according to the current state of the art)
S_N	- The greatest stress which can be sustained for a given number of cycles without fracture
Hz	- Hertz, number of cycles per second
R	- Fatigue ratio, algebraic ratio of the minimum stress to the maximum stress in one cycle
K_t	- Stress concentration factor
S-N Curves	- Plots of stress against number of cycles to failure on testing.

Overall average data (best-value) for tensile and yield strengths of selected materials are plotted in graphical formats to show trends in these properties over the temperature range from 0 to 300 K. If a need occurs for comparing the tensile properties of several materials over this temperature range, the appropriate graphs may be copied and additional data from tables for other materials may be added to achieve the comparisons that are desired.

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2.2 Thermal Properties

Low temperature data (in the 0 to 300 K range) on the thermal conductivity, thermal expansion, and specific heat of materials identified in Section 3 have been collected and organized. The data are representative for metals in the annealed condition and for composites in the as-fabricated condition, unless otherwise noted. All the available thermal property data for the various metals and alloys were plotted and curves were visually fitted. Data read from these curves are presented in tables at selected temperatures in both SI and English units according to the format shown in Table 2.7. Data for composite materials obtained directly from the referenced literature is presented in the format of Table 2.8. The English units are shown in parentheses. Data recorded in the superconducting state are marked (s) while data recorded in the normal state are marked (n).

Thermal conductivity and specific heat data were expanded in the low temperature range by the use of log-log plots. In some areas, extra curves were included to further expand the lower temperature data for better readability.

The thermal expansion data have been referenced to 273 K (32 F). The trends of the thermal expansion data did not change rapidly at the lower temperatures and therefore there was no need to expand the data in the low temperature range.

Impurities, heat treatment, and other conditions affect the low temperature properties of the materials. In some cases, curves showing the effects of these variations are included on the same graph.

Table 2.9 is a list of conversion factors that can be used to convert data to SI units or other familiar units.

2.3 Electrical Resistivity

The electrical resistivity of materials listed in Section 3 have been collected and organized in the temperature range from 0 to 300 K. The data are representative for metals and alloys in the annealed condition and for composites in the as-fabricated condition, unless otherwise noted. The data for the various metals and alloys were plotted and curves were visually fitted. Data read from these curves are presented in tables at selected temperatures in both SI and English units along with the thermal properties in the format shown in Table 2.7. Data for composite materials obtained directly from the referenced literature are presented in the format in Table 2.8.

Electrical resistivity data were expanded in the low temperature range by using log-log plots.

Impurities, variation in heat treatment, and other conditions affect the low temperature electrical resistivity of the materials. Several graphs show how these variables affect the electrical resistivity at low temperatures.

A list of conversion factors for electrical resistivity are also included in Table 2.9.

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2.4 Magnetic Properties

Structural Materials

For the structural materials of specific interest in the development of superconducting machinery, some efforts to determine their magnetic properties have been noted for at least the last 25 years. However, recent interest in cryogenic structural applications has brought forth a resurgence of magnetic property determinations. Most of the data available from the scientific and technical literature is either in the form of magnetization (M) determinations or magnetic susceptibility (k or χ) determinations at various cryogenic temperatures of research interest. This is the case because the magnetic permeability (μ) of these materials generally differs from unity by only a very small amount (in cgsem units).

If available from the literature, values of k are reported in the magnetic property tables in this Handbook, since in some cases they provide a more useful alternative to μ. The volume susceptibility, k, is obtained from reported values of χ, the mass susceptibility, by multiplying the latter by the density of the material, ρ. Values of k are given in mksa units (as used in the SI system) which are 4π times the cgsem units generally used in the scientific literature. In some cases, particularly where no variation in μ may be discerned within computational limits, χ is also reported in the tables.

In the magnetic property tables, μ is also reported in mksa units. To obtain μ in mksa units, μ in cgsem units is multiplied by $4\pi \times 10^{-7}$. In the cgsem system, $\mu = 4\pi k + 1$. Therefore,

$$\mu_{mksa} = (4\pi k_{cgsem} + 1)\, 4\pi \times 10^{-7}.$$

For the structural materials of interest, this relation produces extremely small numerical values of μ, but these satisfy the criterion of the consistent use of SI units for the principal values reported in the tables. It may be noted from the magnetic property tables that μ is somewhat dependent on the magnetizing force (H) applied to the material, even for the materials that have a low value of intrinsic magnetism. It may also be noted that copper is diamagnetic, producing magnetic moments that oppose the applied magnetic field; hence, the susceptibilities are shown with a negative sign.

Superconductive Materials

In correlating property data for a given superconductive material, or group of materials, to achieve optimum design in superconducting machinery, it is desirable to have data on critical current density (J_c) versus temperature (for a given applied magnetic field) or on critical field (H_c) versus temperature (for a given current density). Although a large research effort has been carried out during the past decade to determine the superconducting properties of various materials of technical interest, nearly all of the data produced has been in the form of J_c versus H (for a given temperature). The majority of this experimental data was obtained at 4.2 K. Although working with these data may require considerable extrapolation on the part of the design engineer, it is all that the scientific literature provides at the present time. Therefore, most of the superconducting property data presented in this Handbook is in the form of plots of J_c versus H. Data on the critical (or transition) temperature has been given if available. It may be noted from the data presented that superconductivity is a very structure-sensitive property for any given composition.

TABLE 2.1

Alloy Designation:

Specification:
Form:
Thickness, cm (in.):
Condition:

Testing Temperature, K (F)		297 (75)					
Tension, Longitudinal							
TUS, MN/m^2 (ksi)[a]	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References:

(a) Ksi x 6.895 = MN/m^2

TABLE 2.2

Alloy Designation:

Specification:
Form:
Thickness, cm (in.):
Condition:

Testing Temperature, K (F)	297 (75)					
Compression, Longitudinal						
CYS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Shear						
SUS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)[a] Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., J(ft-lb) Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness						
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)[b] Avg						
Min						
Orientation: –						
No. of Spec. (No. of Heats)						
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.) Avg						
(From PTSC spec.)(–)Min						
No. of Spec. (No. of Heats)						

References:

(a) Ft-lb x 1.356 = Joules.
(b) Ksi $\sqrt{}$in. x 1.093 = $MN^{3/2}$.

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TABLE 2.3

Alloy Designation:

Specification:
Form:
Thickness, cm (in.):
Condition:

Testing Temperature, K (F)	297 (75)					
<u>Fatigue, Axial Loading</u>						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
<u>Fatigue, Flexural Loading</u>						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References:

TABLE 2.4

Composite Class: **Type:**

Specification:
Layup:
Nominal fiber volume fraction:
Nominal ply thickness:

Fiber:
Matrix:
Nominal density:
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)[a]							
TUS, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_1, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2 GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg						
	Min						
References:							
Poisson's Ratio							
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
Tensi							
Tension, Transverse (90°)[b]							
TUS, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_1, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg						
	Min						
References:							
Poisson's Ratio							
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.

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TABLE 2.5

Composite Class: **Type:**

Specification:
Layup:
Nominal fiber volume fraction:
Nominal ply thickness:
Fiber:
Matrix:
Nominal density:
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Compression, Longitudinal (0°)[a]							
CUS, MN/m^2 (ksi)	Max						
	Avg						
	Min						
References:							
CPL, MN/m^2 (ksi)	Max						
	Avg						
	Min						
References:							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
Compression, Transverse (90°)[b]							
CUS, MN/m^2 (ksi)	Max						
	Avg						
	Min						
References:							
CPL, MN/m^2 (ksi)	Max						
	Avg						
	Min						
References:							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
In-Plane Shear							
SUS, MN/m^2 (ksi)	Avg						
	Min						
References:							
SPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
Interlaminar Shear							
SUS, MN/m^2 (ksi)	Avg						
	Min						
References:							
SPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
Impact, Charpy V(Cv), Izod(I)							
Long., (0°) J (ft-lb)[a]	Avg						
	Min						
References:							
Trans., (90°) J (ft-lb)[b]	Avg						
	Min						
References:							
Sheet, Normal, J (ft-lb)[c]	Avg						
	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

TABLE 2.6

Composite Class: **Type:**

Specification: **Fiber:**

Layup: **Matrix:**

Nominal fiber volume fraction: **Nominal density:**

Nominal ply thickness: **Comments:**

Fatigue

Load orientation:

Load direction:

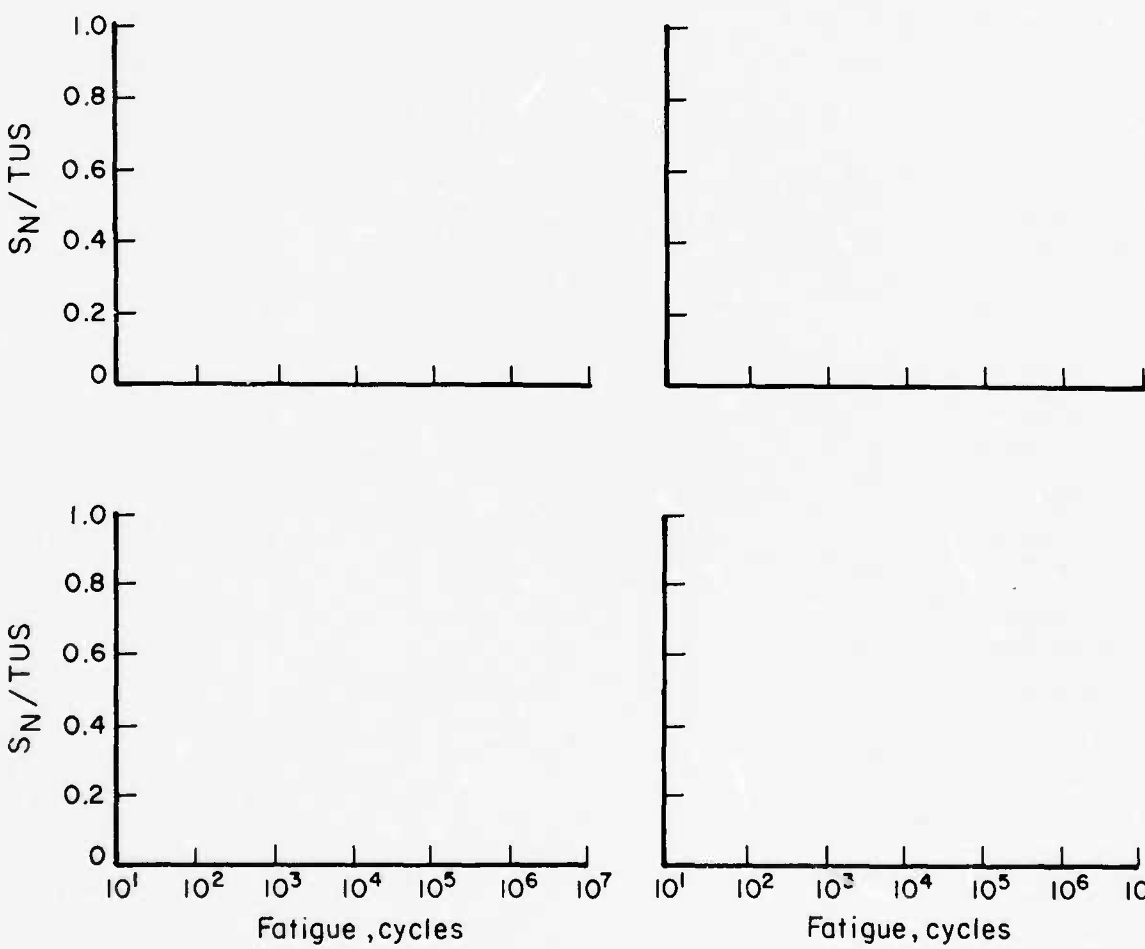

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TABLE 2.7

Alloy Designation:

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

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TABLE 2.8

Composite Class: Type:

Specification: Fiber:
Layup: Matrix:
Nominal fiber volume fraction: Nominal density:
Nominal ply thickness: Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)(a)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Transverse (90°)(b)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Sheet Normal(c)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Thermal Expansion							
Longitudinal (0°)(a)							
10^{-6} $\Delta L/L$	Avg						
References:							
Transverse (90°)(b)							
10^{-6} $\Delta L/L$	Avg						
References:							
Sheet Normal(c)							
10^{-6} $\Delta L/L$	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1}	Avg						
Btu lb^{-1} F^{-1}	Avg						
References:							
Electrical Resistivity							
Longitudinal (0°)(a)							
Ohm m	Avg						
References:							
Transverse (90°)(b)							
Ohm m	Avg						
References:							
Sheet Normal(c)							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.

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TABLE 2.7

Conversion Factors

Temperature (IPTS)

$°F = 9/5\,°C + 32$
$= 9/5\,(°K - 273.15) + 32$
$= °R - 459.67$

$°K = 5/9\,(°F + 459.67)$
$= °C + 273.15$
$= 5/9\,°R$

To Convert To	From	Multiply By
Thermal Conductivity and Magnetothermal Conductivity (Thermochemical Units)		
*Watts m^{-1} K^{-1}	Btu hr^{-1} ft^{-1} F^{-1}	1.730
	Btu in. hr^{-1} ft^{-2} F^{-1}	1.441×10^{-1}
	Cal sec^{-1} cm^{-1} C^{-1}	4.184×10^{2}
	Watts cm^{-1} C^{-1}	1×10^{2}
Btu hr^{-1} ft^{-1} F^{-1}	*Watts m^{-1} K^{-1}	5.782×10^{-1}
	Watts cm^{-1} C^{-1}	57.82
	Cal sec^{-1} cm^{-1} C^{-1}	2.419×10^{2}
	Btu in. hr^{-1} ft^{-2} F^{-1}	8.333×10^{-2}
Specific Heat (Thermochemical Units)		
*Joules kg^{-1} K^{-1}	Btu lb^{-1} F^{-1}	4.184×10^{3}
	Cal g^{-1} C^{-1}	4.184×10^{3}
Btu lb^{-1} F^{-1}	*Joules kg^{-1} K^{-1}	2.390×10^{-4}
	Cal g^{-1} C^{-1}	1
Thermal Expansion		
Percent	*m m^{-1}	1×10^{2}
	in. $in.^{-1}$	1×10^{2}
	cm cm^{-1}	1×10^{2}
Electrical Resistivity		
*Ohm m	Ohm circular mil ft^{-1}	1.662×10^{-9}
	Ohm cm	1×10^{-2}
Ohm circular mil ft^{-1}	*Ohm m	6.015×10^{8}
	Ohm cm	6.015×10^{6}

* SI Units

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3.0 SELECTED MATERIALS FOR DATA COLLECTION

Materials selected for data collection for the second revision of this Handbook are presented in Table 3.1. These materials have been selected from the following classes of materials:

- Aluminum and aluminum alloys
- Copper and copper alloys
- Nickel alloys
- Alloy steels
- Stainless steels
- Titanium and titanium alloys
- Special metals and alloys
- Composites
- Polymers

The two major factors that were considered in selecting these materials were (1) is the material suitable for certain cryogenic components or does it have certain intrinsic properties at cryogenic temperatures for superconducting machinery? and (2) are property data available on the material at cryogenic temperatures?

This second revision also includes properties of welded materials where information was available. When data is reported, the welding method, the type of filler metal, test direction, and test material (i.e., weld metal, or base material plus weld metal) is given.

Because of certain aerospace applications, a considerable amount of data at cryogenic temperatures are available in the literature on alloys such as 2219 aluminum alloy, Type 301 stainless steel, and Ti-5Al-2.5Sn alloy. For other materials, applicable data from the literature may be limited to a few references or may not be available.

The heat treatments and/or processing conditions for the selected alloys are intended to represent conditions that would be most appropriate for cryogenic applications, e.g., conditions that would yield a suitable degree of toughness at cryogenic temperatures. At the same time, the condition of the alloy should be such that it represents a reasonable strength level for the alloy. As an example, mechanical property data are presented for welded Ti-6Al-4V (ELI) alloy in the solution-treated, annealed condition. The annealed alloy has better toughness and develops high strength at very low temperatures. Both the extra low interstitial (ELI) and the normal interstitial content versions of the alloy are considered although the alloy with normal interstitial levels has lower ductility and toughness.

The materials listed in Table 3.1 are divided into numbered sections and subsections to permit adding other materials within each section and subsection while retaining the same numbering system for presenting the data.

The numbering system used for the metals and alloys is carried through to the tables and graphs with additional code letters to identify the properties presented. The code letters are as follows:

ME	Mechanical properties
C	Thermal conductivity
E	Thermal expansion
S	Specific heat
R	Electrical resistivity
TR	Combined thermal and resistance properties
MR	Magnetoresistance
MA	Magnetic properties

Thus, the first graph on thermal conductivity of 1100 aluminum will be Figure 4.1.4-C1. The alloy code number 4.1.4 is for 1100 aluminum, the C indicates thermal conductivity, and the 1 is for the first figure of the series. Figures for thermal conductivity of 1100 aluminum for any temper will be found in this series. The data on welded alloys are indicated in the mechanical properties (ME) sections of the appropriate alloy section.

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TABLE 3.1. NOMINAL COMPOSITIONS OF ALLOYS AND CORRESPONDING SECTION NUMBERS

Section	Aluminum and Aluminum Alloys	Unified No. System	Composition in Weight Percent[a] Si	Cu	Mn	Mg	Cr	Zn	Others
4.0.0	**Aluminum and Aluminum Alloys**								
4.1.0	**Unalloyed Aluminum**								
4.1.1	99.99Al	A91199							
4.1.2	EC	A91145							(99.45 min Al)
4.1.3	1050	A91050	0.25	0.05	0.05	0.05		0.05	(99.50 min Al), 0.40Fe
4.1.4	1100	A91100	1.0(Si+Fe)	0.05-0.20	0.05			0.10	(99.00 min Al)
4.2.0	**2000 Series**								
4.2.1	2014	A92014	0.5-1.2	3.9-5.0	0.4-1.2	0.2-0.8	0.10	0.25	0.7Fe, 0.15Ti
4.2.2	2219	A92219	0.20	5.8-6.8	0.2-0.4	0.02		0.10	0.3Fe, 0.02-0.10Ti
4.2.3	2024	A92024		4.5	0.6	1.5			
4.3.0	**5000 Series**								
4.3.1	5083	A95083	0.40	0.10	0.4-1.0	4.0-4.9	0.05-0.25	0.25	0.4Fe, 0.15Ti
4.3.2	5456	A95456		0.15	0.7	0.5	0.15		
4.4.0	**6000 Series**								
4.4.1	6061	A96061	0.4-0.8	0.15-0.40	0.15	0.8-1.2	0.04-0.35	0.25	0.7Fe, 0.15Ti
4.5.0	**7000 Series**								
4.5.1	7039	A97039	0.30 max	0.10 max	0.25	2.8	0.20	4.0	0.4 max Fe, 0.10 max Ti
4.5.2	7005	A97005	0.35 max	0.10 max	0.2-0.7	1.0-1.8	0.06-0.20	4.2-5.0	0.01-0.06Ti, 0.06-0.20Zr, 0.35 max Fe
4.5.3	7006	—	0.10	0.04	0.22	2.24	0.12	4.10	0.17Fe, 0.01Ti

Section	Copper and Copper Alloys		CDA No.	Composition in Weight Percent[a] Cu	Pb	Fe	Zn	Others
5.0.0	**Copper and Copper Alloys**							
5.1.0	**99.9+Cu**							
5.1.1	99.96Cu	C10100	101	99.96+				0.0003 max P, 0.001 max Pb
5.1.2	Electrolytic Tough Pitch	C11000	110	99.9+				
5.1.3	OFHC	C10200	102	99.95				
5.1.4	Phosphorized	C12200	122	99.9+				0.02P
5.2.0	**Cu-Zn Alloys**							
5.2.1	80Cu-20Zn	C24000	240	80	0.05 max	0.05 max	20	
5.2.2	70Cu-30Zn	C26000	260	70	0.07 max	0.05 max	30	
5.2.4	90Cu-10Zn	C22000	220	90	0.05 max	0.05 max	10	
5.3.0	**Cu-Ni Alloys**							
5.3.1	90Cu-10Ni	C70600	706	Bal.	0.05 max	1.0		1.0Mn, 9.0-11.0Ni
5.3.2	80Cu-20Ni	C71000	710	Bal.	0.05 max	1.0 max	1.0 max	1.0 max Mn, 19.0-23.0Ni
5.3.3	70Cu-30Ni	C71500	715	Bal.	0.05 max	0.4-0.7	1.0 max	1.0 max Mn, 29.0-33.0Ni
5.4.0	**Cu-Be Alloys**							
5.4.1	Cu-Be(1.6-1.8)	C17000	170	Bal.				1.6-1.8Be, 0.20-.40Co
5.4.2	Cu-Be(1.8-2.0)	C17200	172	Bal.				1.8-2.0Be, 0.20 min (Ni+Co) 0.60 max (Ni+Co+Fe)
5.5.0	**Cu-Sn Alloys**							
5.5.1	95Cu-5Sn	C51800	518	Bal.	0.02 max			4.0-6.0Sn, 0.10-0.35P
5.5.2	92Cu-8Sn	C52100	521	Bal.	0.05 max	0.10 max	0.20 max	7.0-9.0Sn, 0.03-0.35P
5.5.3	90Cu-10Sn	C52400	524	Bal.	0.05 max	0.10 max	0.20 max	9.0-11.0Sn, 0.03-0.35P
5.6.0	**Cu-Zr Alloy**							
5.6.1	Cu-0.2Zr (Amzirc)	C15000	150	99.8				0.10-0.20Zr
5.7.0	**Cu-Cr-Cd Alloy**							
5.7.1	Cu-0.4Cr-0.4Cd (PD-135)	—	—	Bal.				0.4Cr, 0.4Cd (Te deox.)

(a) max = maximum, min = minimum.

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TABLE 3.1. (Continued)

Section						Others
5.8.0	**Cu-Al_2O_3 Alloys**					
5.8.1	Cu+0.2Al_2O_3	(AL-10)	–	Bal.		0.2Al_2O_3 dispersion
5.8.2	Cu+0.7Al_2O_3	(AL-35)	–	Bal.		0.7Al_2O_3 dispersion
5.8.3	Cu+1.1Al_2O_3 (GlidCop Alloys)	(AL-60)	–	Bal.		1.1Al_2O_3 dispersion
5.9.1	Cu-Al	C61400				6.0-8.0Al, 1.0 max Mn 0.01 max Pb, 2.5Fe, 0.20 max Zn

Section	Nickel and Cobalt Alloys	Unified No. System	Ni	Cr	Fe	Mn	Si	C	Others
6.0.0	**Nickel and Cobalt Alloys**		Composition in Weight Percent[(a)]						
6.1.0	Ni-Cu Alloy								
6.1.1	K Monel (K-500)	N05500	Bal.		1.0	0.6	0.15	0.15	29.5Cu, 2.8Al, 0.5Ti
6.2.0	**Ni-Cr-Fe Alloys**								
6.2.1	Inconel 600	N06600	Bal.	15.8	7.2	0.2	0.2	0.04	0.10Cu
6.2.2	Inconel X-750	N07750	Bal.	15.0	6.75	0.7		0.04	0.8Al, 2.5Ti, 0.85Nb
6.2.3	Inconel 718	N07718	Bal.	18.6	18.5			0.04	0.4Al, 0.9Ti, 5.0Nb, 3.1Mo
6.2.4	Inconel 706	N09706	39-44	16	Bal.	0.35 max	0.35 max	0.06 max	0.35 max Al, 0.01-0.02B, 3Nb, 1.5-2.0Ti
6.3.0	**Controlled Expansion Alloys**								
6.3.1	Invar 36	–	36		Bal.				
6.3.2	Ni-Span C	–	42.1(Ni+Co)	5.4	48.4	0.40			2.4Ti, 0.65Al
6.3.3	Unnamed Inco LEA Alloy	–	39.6		55.4	0.22	0.12	0.01	0.22Al, 1.46Ti, 2.90Nb+Ta
6.4.0	**Pure Nickels**								
6.4.1	High-Purity Ni	–							
6.4.2	Nickel "A"	–							

Section			C max	Mn max	P max	S max	Si	Ni	Others
7.0.0	**Alloy Steels**		Composition in Weight Percent[(a)]						
7.1.0	**Nickel Steels**								
7.1.1	9-Ni Steel	–	0.13	0.80	0.036	0.04	0.15-0.30	8.5-9.5	
7.1.2	18Ni(200) Maraging	–	0.03	0.10	0.01	0.01	0.10	17-19	8.5Co, 3.25Mo, 0.20Ti, 0.10Al
7.2.0	**Fe-Si Steel**								
7.2.1	Transformer Steel								
7.3.0	**Carbon Steels**								
7.3.1	AISI 1010	G10100	0.08-0.13	0.30-0.60	0.040	0.050			
7.4.0	***Other Ferrous Materials***								
7.4.1	Armco Iron								
7.4.3	5-Ni Steel		0.15	0.30-0.60	0.035	0.035	0.2-0.35	5.0	0.20-0.35Mo, 0.05-0.12Al, 0.02 max Ni
7.4.4	Iron (47-50)Ni Alloy								

Section			C	Mn	P max	S	Si	Cr	Ni	Mo	Others
8.0.0	**Stainless Steels**		Composition in Weight Percent[(a)]								
8.1.0	**300 Series**										
8.1.1	AISI 301	S30100	0.15 max	2.0 max	0.045	0.03 max		16-18	6-8		
8.1.2	AISI 304	S30400	0.08 max	2.0 max	0.045	0.03 max	1.0 max	18-20	8-10.5		
8.1.3	AISI 304L	S30403	0.03 max	2.0 max	0.045	0.03 max	1.0 max	18-20	8-12		
8.1.4	AISI 310	S31000	0.25 max	2.0 max	0.045	0.03 max	1.5 max	24-26	19-22		
8.1.5	AISI 316	S31600	0.08 max	2.0 max	0.045	0.03 max	1.0 max	16-18	10-14	2.0-3.0	
8.1.6	AISI 321	S32100	0.08 max	2.0 max	0.045	0.03 max	1.0 max	17-19	9-12		(5xC)Ti min
8.1.7	AISI 303	S30300	0.15 max	2.0 max	0.20	0.16 min	1.0 max	17-19	8-10	0.6 max (or Zr)	
8.1.8	AISI 310S	S31008	0.08 max	2.0 max	0.045	0.03 max	1.5 max	24-26	19-22		
8.1.9	AISI 347	S34700	0.08 max	2.0 max	0.045	0.03 max	1.0 max	17-19	9-13		(10xC)Nb+Ta
8.1.10	AISI 410	S41000	0.15	1.0 max	0.040	0.03 max	1.0 max	11.5-13.5			
8.1.11	AISI 416	S41600	0.15	1.25 max	0.06		1.0 max	12-14		0.6 max	0.153 min
8.2.0	**Other Stainless Steels**										
8.2.1	A-286	K66286	0.05	1.4			0.4	15	26	1.25	0.2Al, 2.15Ti, 0.003B, 0.3V
8.2.2	Kromarc-58[(b)]	–	0.03	9.3	0.005	0.005 max	0.05	15.5	23	2.2	0.02Al, 0.008Zr, 0.016B, 0.16V, 0.17Ni
8.2.3	Armco 21-6-9	–	0.08 max	8.0-10.0				19.0-21.5	5.5-7.5		
8.2.4	Armco 22-13-5	–	0.06 max	4.0-6.0			1.0 max	20.5-23.5	11.5-13.5	1.5-3.0	0.1-0.3Nb, 0.1-0.3V, 0.2-0.4N

(a) max = maximum, min = minimum.
(b) Analysis of Westinghouse plate used in evaluation program.

TABLE 3.1. (Continued)

Section		Composition in Weight Percent[a]								
		Al	Sn	V	Fe max	O max	C max	N max	H max	Mn max
9.0.0	**Titanium and Titanium Alloys**									
9.1.0	**Unalloyed Ti**									
9.1.1	Ti-65A						0.20	0.07	0.015	
9.1.2	Ti-75A					0.40	0.20	0.07	0.0125	
9.2.0	**Alpha Ti Alloys**									
9.2.1	Ti-5Al-2.5Sn[c]	4.0-6.0	2.0-3.0		0.50	0.20	0.15	0.07	0.020	0.30
9.2.2	Ti-5Al-2.5Sn (ELI)[d]	4.7-5.6	2.0-3.0		0.20	0.12	0.08	0.05	0.0175	
9.3.0	**Alpha-Beta Ti Alloy**									
9.3.1	Ti-6Al-4V (ELI)[d]	5.5-6.5		3.5-4.5	0.15	0.13	0.08	0.05	0.015	
9.3.2	Ti-6Al-4V[c]	5.5-6.75		3.5-4.5						
10.0.0	**Special Metals and Alloys**									
10.1.0	**Nb and Nb Alloys**									
10.1.1	Nb									
10.1.2	Nb_3Sn									
10.1.3	Nb-Zr									
10.1.4	Nb-Ti									
10.1.5	Nb-Ti+Cu composites									
10.2.0	***V-Ga Alloys***									
10.2.1	V_3Ga									
10.3.1	Magnesium Alloy AZ31B (3Al, 1Zn, 0.2Mn) Mg-Al-Mn Alloy									
11.0.0	**Composites**									
11.1.0	**Glass-Epoxy**									
11.1.1	181/Epox 828									
11.1.2	1581/E-787 (58-68R)									
11.1.3	S-901/NASA Resin 2									
11.2.0	**Boron-Epoxy**									
11.2.1	4.0 mil Boron/2387									
11.2.2	5.0 mil Boron/2387									
11.3.0	**Graphite-Epoxy**									
11.3.1	AS/NASA Resin 2									
11.3.2	HT-S/X-904									
11.4.0	**Boron-Aluminum**									
11.4.1	5.6 mil Boron/6061									

Section		
12.0.0	**Polymers**	
12.1.1	PE	Polyethylene
12.1.2	PCTFE	Polychlorotrifluoroethylene
12.1.3	PTFE	Polytetrafluoroethylene
12.2.1	PMM	Polymethylmethacrylate
12.3.1	PS	Polystyrene
12.4.1	PVA	Polyvinylacetate

(a) max = maximum, min = minimum.
(c) Normal interstitial content.
(d) ELI = extra low interstitial type.

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TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties														Thermal-Electrical Properties						Magnetic Properties	
					Weld Properties				Tensile			Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)		C	C	E	S	R	MR		Magnetic Moment
Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S-N	E, G, B, ρ	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Perm., Suscept
Aluminum Alloys																										
Aluminum	4.1.1	Rod	F					ME								F0.1										
Aluminum	4.1.1			Annealed				ME										TR	1,F1		1,F1	1,F1,F2,F3	1,F1		MA	1
1099-H14	4.1.4	Plate	E	H14				ME	1,F1																	
1100-H112	4.1.4	Plate	E	H112	MIG	1100	AW	ME	1.1		1.1															
1100-O	4.1.4	Bar	F	O				ME	2,F1																	
1100-O	4.1.4	Rod	F	O				ME									3									
1100-O	4.1.4			O														TR	1,F0.1,F1,F2		1,F1	1,F1,F2				
2014-T6	4.2.1	Sheet	A	T6				ME	1									TR	1,F1				1			
2014-T6	4.2.1	Sheet	B	T6				ME	2,4	2	2,4					3,F2										
2014-T6	4.2.1	Sheet	B	T6	MIG	4043	AW	ME	4.1																	
2014-T6	4.2.1	Sheet	B	T6	TIG	2014	AW	ME	4.2	4.2																
2014-T6	4.2.1	Sheet	B	T6	TIG	2319	AW	ME	4.3							F3										
2014-T6	4.2.1	Sheet	B	T6	TIG	4043	AW	ME	4.4,4.5																	
2014-T6	4.2.1	Sheet	C	T6				ME	5																	
2014-T6	4.2.1	Sheet	C	T6	TIG	4043	AW	ME	5.1																	
2014-T6	4.2.1	Plate	D	T6	MIG	716	AW	ME	5.2																	
2014-T6	4.2.1	Plate	D	T6	MIG	2319	AW	ME	5.3																	
2014-T6	4.2.1	Plate	D	T6	MIG	4043	AW	ME	5.4																	
2014-T6	4.2.1	Plate	D	T6	MIG	5356	AW	ME	5.5																	
2014-T6	4.2.1	Plate	D	T6	MIG	5556	AW	ME	5.6																	
2014-T6	4.2.1	Plate	E	T62				ME	6					7												
2014-T651	4.2.1	Plate	E	T651				ME	8		8			9												
2014-T62	4.2.1	Plate	E	T62	TIG	2319	AW	ME	9.1						F4											
2014-T62	4.2.1	Plate	E	T62	TIG	4043	AW	ME	9.2						F4											
2014-T651	4.2.1	Plate	G	T651				ME	9.3		9.3															
2014-T6	4.2.1	Bar	F	T6				ME	10	10																
2014-T6	4.2.1	Forging		T6				ME	11																	
2024-T3	4.2.3	Sheet	A	T3				ME	1	1	1															
2024-T4	4.2.3	Sheet	A	T4				ME	2	2	2															
2024-T3	4.2.3	Sheet	B	T3				ME	3		3															
2024-T86	4.2.3	Sheet	B	T86				ME	4		4															
2024-T351	4.2.3	Plate	E	T351				ME	5		5															
2024-T4	4.2.3	Plate	G	T4				ME	6	6	6															
2024-T851	4.2.3	Plate	G	T851				ME	7		7															
2024-T4	4.2.3	Bar	F	T4				ME	8																	
2024-T4	4.2.3	Bar	F	T4				ME					9													
2024-T86	4.2.3	Bar	F	T86				ME	10																	
2024-T86	4.2.3	Bar	F	T86				ME					11													
2024-T351	4.2.3	Bar	G	T351				ME	12		12															
2024-O	4.2.3			O														TR	1,F1		1,F1		1,F1			
2024-T4	4.2.3			T4														TR	2,F2			2,F1	2,F2			
2024-T6	4.2.3			T6														TR					3,F3			
2024-T86	4.2.3			T86														TR	4,F3		4,F2		4,F4			
2219-T87	4.2.2	Sheet	A	T87				ME	1																	
2219-T6	4.2.2	Sheet	B	T6				ME	2																	
2219-T62	4.2.2	Sheet	B	T62				ME	3	3	3					4										
2219-T81	4.2.2	Sheet	B	T81				ME	5	5	5															
2219-T87	4.2.2	Sheet	B	T87				ME	6	6	6					7										
2219-T6E46	4.2.2	Sheet	B	T6E46				ME	7.1																	
2219-T31	4.2.2	Sheet	B	T31	TIG	2319	AW	ME	7.2																	
2219-T6	4.2.2	Sheet	B	T6	TIG	2319	AW	ME	7.3																	
2219-T62	4.2.2	Sheet	B	T62	MIG	2319	T62	ME	7.4	7.4	7.4															
2219-T62	4.2.2	Sheet	B	T62	MIG	2319	HT,A	ME	7.5	7.5																
2219-T62	4.2.2	Sheet	B	T62	TIG	2319	AW	ME	7.6		7.6															
2219-T62	4.2.2	Sheet	B	T62	TIG	2319	T62	ME	7.7		7.7															
2219-T62	4.2.2	Sheet	B	T62	TIG	2319	T62	ME	7.8																	
2219-T81	4.2.2	Sheet	B	T81	MIG	2319	AW	ME	7.9		7.9															
2219-T81	4.2.2	Sheet	B	T81	MIG	2319	Aged	ME	7.10		7.10															
2219-T81	4.2.2	Sheet	B	T81	TIG	2319	AW	ME	7.11																	
2219-T81	4.2.2	Sheet	B	T81	TIG	2319	AW	ME	7.12																	
2219-T81	4.2.2	Sheet	B	T81	TIG	2319	T81	ME	7.13																	
2219-T87	4.2.2	Sheet	B	T87	MIG	2319	AW	ME	7.14		7.14															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties													Thermal-Electrical Properties							Magnetic Properties	
					Weld Properties				Tensile			Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)		C	C	E	S	R	MR		Magnetic Moment
Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S-N	E, G, B, ρ	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Perm., Suscept.
2219-T87	4.2.2	Sheet	B	T87	MIG	2319	Aged	ME	7.15		7.15															
2219-T87	4.2.2	Sheet	B	T87	TIG	2319	AW	ME	7.16	7.16																
2219-T87	4.2.2	Sheet	C	T87	TIG	2319	AW	ME	7.17																	
2219-T81	4.2.2	Plate	D	T81				ME	8		8	9														
2219-T87	4.2.2	Plate	D	T87				ME	10		10															
2219-T6E46	4.2.2	Plate	D	T6E46				ME	10.1	10.1																
2219-O	4.2.2	Plate	D	O	TIG	2319	HT	ME	10.2																	
2219-T87	4.2.2	Plate	E	T87				ME	11	11	11		12	12												
2219-T6E46	4.2.2	Plate	E	T6E46				ME	12.1	12.1																
2219-T851	4.2.2	Plate	E	T851				ME	12.2		12.2															
2219-T6E46	4.2.2	Plate	E	T6E46	TIG	2319	AW	ME	12.3																	
2219-T62	4.2.2	Plate	E	T62	MIG	2319	AW	ME	12.4																	
2219-T81	4.2.2	Plate	E	T81	MIG	2319	AW	ME	12.5																	
2219-T81	4.2.2	Plate	E	T81	MIG	2319	Aged	ME	12.6																	
2219-T87	4.2.2	Plate	E	T87	MIG	2319	AW	ME	12.7		12.7															
2219-T87	4.2.2	Plate	E	T87	MIG	2319	HT	ME	12.8																	
2219-T87	4.2.2	Plate	E	T87	TIG	2319	AW	ME	12.9		12.9															
2219-T87	4.2.2	Plate	E	T87	TIG	None	AW	ME	12.10	12.10																
2219-T87	4.2.2	Plate	G	T87				ME	13,14	13	13			15												
2219-T6E46	4.2.2	Plate	G	T6E46				ME	15.1																	
2219-T62	4.2.2	Plate	G	T62				ME	15.2		15.2															
2219-T851	4.2.2	Plate	G	T851	MIG	2319	AW	ME	15.3																	
2219-T81	4.2.2	Plate	H	T81				ME	16,17																	
2219-T87	4.2.2	Plate	H	T87				ME	18,19	18,19	18,19															
2219-T87	4.2.2	Sheet & Plate	A-H	T87				ME	20																	
2219-T87	4.2.2	Plate	H	T87				ME						21												
2219-T81	4.2.2	Plate	H	T81	MIG	2319	AW	ME	21.1																	
2219-T87	4.2.2	Plate	H	T87	EB	2319	AW	ME	21.2	21.2																
2219-T87	4.2.2	Plate	H	T87	EB	2319	Aged	ME	21.3	21.3																
2219-T87	4.2.2	Plate	H	T87	MIG	2319	AW	ME	21.4	21.4																
2219-T87	4.2.2	Plate	H	T87	MIG	2319	Aged	ME	21.5	21.5																
2219-T87	4.2.2	Plate	H	T87	MIG	2319	Aged	ME						21.6												
2219-T87	4.2.2	Plate	H	T87	Pulse TIG	2319	AW	ME	21.7	21.7																
2219-T87	4.2.2	Plate	H	T87	Pulse TIG	2319	Aged	ME	21.8	21.8																
2219-T87	4.2.2	Plate	H	T87	Pulse TIG	2319	Aged	ME						21.9												
5083-H38	4.3.1	Sheet	B	H38				ME	1		1															
5083-H113	4.3.1	Plate	D	H113				ME								2										
5083-H113	4.3.1	Plate	D	H113	MIG	5183	AW	ME	2.1																	
5083-H113	4.3.1	Plate	D	H113	MIG	5183	AW	ME								2.2										
5083-O	4.3.1	Plate	E	O				ME	3		3															
5083-O	4.3.1	Plate	E	O	MIG	5183		ME	3.1		3.1															
5083-H113	4.3.1	Plate	E	H113	MIG	5556	AW	ME	3.2																	
5083-H113	4.3.1	Plate	E	H113	MIG	5556	AW	ME								3.3										
5083-H321	4.3.1	Plate	E	H321	MIG	5183	AW	ME	3.4		3.4															
5083-H321	4.3.1	Plate	E	H321	MIG	5356	AW	ME	3.5		3.5															
5083-H321	4.3.1	Plate	E	H321	MIG	5556	AW	ME	3.6		3.6															
5083-O	4.3.1	Plate	G	O	MIG	5183	AW	ME	3.7																	
5083-O	4.3.1	Plate	G	O	MIG	5356	AW	ME	3.8																	
5083-O	4.3.1	Sheet/ Plate	B/H	O				ME	4																	
5083-H113	4.3.1	Plate	E	H113				ME	5		5															
5083-O	4.3.1	Plate	E	O				ME									5.1									
5083-H113	4.3.1	Plate	E	H113				ME								6										
5083-H321	4.3.1	Plate	E	H321				ME	7		7															
5083-O	4.3.1	Plate	H	O				ME	8																	
5083-O	4.3.1	Plate	H	O				ME	9																	
5083-O	4.3.1	Plate	H	O	MIG	5183	AW	ME	9.1																	
5456-O	4.3.2	Sheet	B	O				ME	1		1															
5456-H24	4.3.2	Sheet	B	H24				ME	2	2	2															
5456-H24	4.3.2	Sheet	B	H24	TIG	4043	AW	ME	3																	
5456-H321	4.3.2	Sheet	B	H321				ME	4		4															

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TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties													Thermal-Electrical Properties							Magnetic Properties	
					Weld Properties				Tensile			Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)		C	C	E	S	R	MR		Magnetic
Material	Mat'l Code	Form	Thickness(f) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S-N	E, G, B, ρ	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Moment Perm., Suscept
5456-H321	4.3.2	Sheet	B	H321	TIG	5556	AW	ME	5		5															
5456-H343	4.3.2	Sheet	B	H343				ME	6	6	6					F1,F2										
5456-H343	4.3.2	Sheet	B	H343	TIG	5356	AW	ME	7																	
5456-H343	4.3.2	Sheet	B	H343	TIG	5556	AW	ME	8							F3										
5456-O	4.3.2	Plate	D	O				ME	9		9															
5456-O	4.3.2	Plate	D	O				ME				10														
5456-H321	4.3.2	Plate	D	H321				ME				11														
5456-O	4.3.2	Plate	E	O				ME	12		12															
5456-H321	4.3.2	Plate	E	H321				ME	13		13															
5456-H321	4.3.2	Plate	E	H321				ME								14										
5456-H321	4.3.2	Plate	E	H321	MIG	5556	AW	ME	15																	
5456-H321	4.3.2	Plate	E	H321	MIG	5556	AW	ME								16										
5456-H343	4.3.2	Plate	E	H343				ME	17		17															
5456-H343	4.3.2	Plate	E	H343	MIG	5356	AW	ME	18																	
5456-H343	4.3.2	Plate	E	H343	TIG	5356	AW	ME	19																	
5456-H321	4.3.2	Plate	G	H321				ME	20		20															
5456-H343	4.3.2			H343														TR	1,F1		1,F1		1,F1			
6061-T4	4.4.1	Sheet	A	T4				ME	0.1		0.1															
6061-T4	4.4.1	Sheet	A	T4				ME	0.2		0.2															
6061-T6	4.4.1	Sheet	A	T6				ME	1		1															
6061-T6	4.4.1	Sheet	B	T6				ME	2	2	2															
6061-T6	4.4.1	Sheet	B	T6				ME	F1							3										
6061-T4	4.4.1	Sheet	B	T4	MIG	4043	AW	ME	3.1		3.1															
6061-T4	4.4.1	Sheet	B	T4	MIG	4043	T6	ME	3.2		3.2															
6061-T6	4.4.1	Sheet	B	T6	MIG	4043	AW	ME	3.3		3.3															
6061-T6	4.4.1	Sheet	B	T6	TIG	4043	AW	ME	3.4																	
6061-T6	4.4.1	Plate	D	T6				ME	4		4															
6061-T6	4.4.1	Plate	D	T6				ME				5	5													
6061-T6	4.4.1	Plate	E	T6				ME	6,F1																	
6061-T6	4.4.1	Plate	E	T6	MIG	4043	AW	ME	6.1		6.1															
6061-T6	4.4.1	Plate	E	T6	MIG	4043	HT	ME	6.2		6.2															
6061-T6	4.4.1	Plate	E	T6	MIG	5356	AW	ME	6.3		6.3															
6061-T6	4.4.1	Plate	E	T6	MIG	5356	HT	ME	6.4		6.4															
6061-T651	4.4.1	Plate	G	T651				ME	7		7															
6061-T651	4.4.1	Plate	G	T651				ME						8												
6061-T6	4.4.1	Bar	F	T6				ME	9																	
6061-T6	4.4.1	Bar	F	T6				ME	F1				10													
6061-T6	4.4.1	Bar	F	T6				ME								11										
6061-O	4.4.1	Rod	F	O				ME	11.1																	
6061-T4	4.4.1	Rod	F	T4				ME	11.2																	
6061-T91	4.4.1	Rod	F	T91				ME	11.3																	
6061-T6	4.4.1	Forging		T6				ME	12		12															
6061-T6	4.4.1			T6														TR			1		1			
7005-T6	4.5.2	Sheet	B	T6				ME	1		1															
7005-O	4.5.2	Plate	E	O				ME									2									
7005-T6351	4.5.2	Plate	E	T6351				ME	2.1		2.1															
7005-T6351	4.5.2	Plate	H	T6351				ME	2.2		2.2															
7005-T5351	4.5.2	Extrusion	G	T5351				ME	3		3															
7006-T6	4.5.3	Sheet	B	T6				ME	1		1															
7006-T63	4.5.3	Sheet	B	T63				ME	2		2															
7006-W	4.5.3	Sheet	B	W				ME	3		3															
7039-T6	4.5.1	Sheet	A	T6				ME	1		1															
7039-T6	4.5.1	Sheet	B	T6				ME	2	2	2															
7039-T6	4.5.1	Sheet	B	T6				ME	F1							3										
7039-T6	4.5.1	Sheet	B	T6	MIG	5183	Aged	ME	3.1		3.1															
7039-T6	4.5.1	Sheet	B	T6	Fusion	Not given	AW	ME	3.2																	
7039-T61	4.5.1	Sheet	C	T61				ME	4																	
7039-T61	4.5.1	Sheet	C	T61	TIG	None	AW	ME	4.1																	
7039-T61	4.5.1	Sheet	C	T61	TIG	None	Aged	ME	4.2																	
7039-T6,T61	4.5.1	Plate	D	T6,T61				ME	5		5															
7039-T6	4.5.1	Plate	D	T6	MIG	5083	Aged	ME	5.1		5.1															
7039-T6	4.5.1	Plate	D	T6	TIG	5039	Aged	ME	5.2		5.2															
7039-T6	4.5.1	Plate	D	T6	TIG	None	Aged	ME	5.3		5.3															

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TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness[l] Code	Condition[c,d,e]	Mechanical Properties: Weld Properties: Process[j]	Weld Properties: Filler Alloy	Weld Properties: Post-Weld[k] Treatment	Tensile: Prop Code	Tensile: Ultimate Prop	Tensile: Elastic Prop	Tensile: NTS	Shear SUS G	Impact Charpy V	Fracture Toughness K_{IC}, K_{IE}, J_{IC}	Fatigue da/dN	Fatigue S-N	Dynamic Moduli[b] E, G, B, ρ	Thermal-Electrical Properties: Prop Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties: Prop Code	Magnetic Moment Perm., Suscept
7039-T64	4.5.1	Plate	D	T64	MIG	5039	AW	ME	5.4																	
7039-T6,T61	4.5.1	Plate	E	T6,T61				ME	6,F1		6															
7039-T6	4.5.1	Plate	E	T6	MIG	5039	Aged	ME	6.1		6.1															
7039-T6	4.5.1	Plate	E	T6	MIG	5183	Aged	ME	6.2		6.2															
7039-T6	4.5.1	Plate	E	T6	TIG	5039	Aged	ME	6.3		6.3															
7039-T6	4.5.1	Plate	E	T6	TIG	5183	Aged	ME	6.4		6.4															
7039-T6	4.5.1	Plate	E	T6	TIG	None	Aged	ME	6.5		6.5															
7039-T61	4.5.1	Plate	E	T61	MIG	5039	Aged	ME	6.6		6.6															
7039-T6151	4.5.1	Plate	E	T6151				ME	6.7		6.7															
7039-T6151	4.5.1	Plate	E	T6151	MIG	5039	AW	ME	6.8		6.8															
7039-T6351	4.5.1	Plate	E	T6351				ME	6.9		6.9															
7039-T64	4.5.1	Plate	E	T64	MIG	5039	AW	ME	6.10																	
7039-T6,T61	4.5.1	Plate	G	T6,T61				ME	7		7															
7039-T6,T61	4.5.1	Plate	G	T6,T61				ME						8												
7039-T64	4.5.1	Plate	G	T64				ME	8.1		8.1															
7039-T6	4.5.1	Plate	H	T6				ME	9		9															
7039-T6	4.5.1	Plate	H	T6				ME	10		10															
7039-T6,T61	4.5.1	Extrusion	G	T6,T61				ME	11		11															
7039-T6,T61	4.5.1	Extrusion	G	T6,T61				ME	12		12															
7039-T61	4.5.1			T61														TR	1,F1		1,F1		1,F1			
Copper and Copper Alloys																										
Copper	5.1.1																	TR						F1,F2,F3		
Cu, 99.96	5.1.1			Annealed														TR	1,F1	1	1,F1	1,F1,F2	1,F1,F2			
Cu, 99.96+	5.1.1	Wire		Etched, CD, annealed																					MA	1
																									MA	2
Cu, 99.96+	5.1.1	Rod		As formed																					MA	3
Cu, 99.96+	5.1.1	Rod		Annealed																					MA	4
Cu, 99.96+	5.1.1	Rod		Annealed																						
Electrolytic Tough Pitch Cu	5.1.2	Sheet	B	Hot rolled, annealed				ME	1,F1																	
Electrolytic Tough Pitch Cu	5.1.2	Sheet	C	HR, annealed, CR				ME	2																	
Electrolytic Tough Pitch Cu	5.1.2	Plate	D	HR, annealed				ME	3,F1																	
Electrolytic Tough Pitch Cu	5.1.2	Plate	D	HR, annealed, CR				ME	4																	
Electrolytic Tough Pitch Cu	5.1.2			Annealed														TR	1,F1							
OFHC Cu	5.1.3	Sheet	A	Annealed				ME	1,F1																	
OFHC Cu	5.1.3	Sheet	B	HR, annealed				ME	2																	
OFHC Cu	5.1.3	Sheet	C	HR, annealed, CR				ME	3																	
OFHC Cu	5.1.3	Plate	D	HR, annealed				ME	4																	
OFHC Cu	5.1.3	Plate	D	HR, annealed, CR				ME	5																	
OFHC Cu	5.1.3	Plate	E	Stress relieved				ME	6		6															
OFHC Cu	5.1.3	Annealed						ME	6.1,F1																	
OFHC Cu	5.1.3	Wire		Hard drawn				ME	7	7																
OFHC Cu	5.1.3	Bar	F	Annealed				ME	8																	
OFHC Cu	5.1.3	Bar	F	Vac annealed				ME	9	9																
OFHC Cu	5.1.3	Bar	F	Cold drawn				ME	10,F1		10															
OFHC Cu	5.1.3			Annealed														TR	1,F1	1,F2	1,F1	1	1,F1	1,F1		
OFHC Cu	5.1.3	Rod		Annealed																					MA	1
Cu, phosphorized	5.1.4	Sheet	B	HR, annealed				ME	1,F1																	
Cu, phosphorized	5.1.4	Sheet	C	HR, annealed, CR				ME	2																	
Cu, phosphorized	5.1.4	Plate	D	HR, annealed				ME	3																	
Cu, phosphorized	5.1.4	Plate	D	HR, annealed, CR				ME	4																	
Cu, phosphorized	5.1.4	Bar	F	Annealed				ME	5	5	5															
Cu, phosphorized	5.1.4	Bar	F	Annealed				ME	F1			6														
Cu, phosphorized	5.1.4	Bar	F	Cold drawn				ME	7,F1	7	7															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties													Thermal-Electrical Properties							Magnetic Properties	
					Weld Properties				Tensile			Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)		C	C	E	S	R	MR		Magnetic Moment
Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S-N	E, G, B, μ	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Perm., Suscept
Cu, phosphorized	5.1.4			Annealed														TR	1,F1							
80Cu-20Zn	5.2.1			Annealed														TR	1,F1			1,F1				
70Cu-30Zn	5.2.2	Sheet	B	Stress relieved				ME	1 1																	
70Cu-30Zn	5.2.2	Sheet	B	Stress relieved				ME								2										
70Cu-30Zn	5.2.2	Bar	F	3/4 hard				ME	3																	
70Cu-30Zn	5.2.2	Bar	F	3/4 hard				ME	F1				4													
70Cu-30Zn	5.2.2			Annealed														TR1	1,F1,2,F2							
66Cu-35Zn	5.2.3			Annealed														TR	1,F1		1,F1	1,F1				
90Cu-10Zn	5.2.4	Bar	F	Annealed				ME	1	1	1															
90Cu-10Zn	5.2.4	Bar	F	Annealed				ME				2	2													
90Cu-10Zn	5.2.4			Annealed														TR	1,F1			1,F1,F2	1,F1			
Cu-Ni Alloys	5.3.0	Strip		Annealed																					MA	F1
90Cu-10Ni	5.3.1	Plate	E	Annealed				ME	0.1																	
90Cu-10Ni	5.3.1	Bar	F	Annealed				ME	1,F1	1	1															
90Cu-10Ni	5.3.1			Annealed														TR	1,F1			1,F1	1,F1			
90Cu-10Ni	5.3.1	Rod		Homogenized																					MA	1
80Cu-20Ni	5.3.2	Plate	E	Annealed				ME	1																	
80Cu-20Ni	5.3.2	Plate	E		MIG	80Cu-20Ni	AW	ME					2													
80Cu-20Ni	5.3.2			Annealed														TR	1,F1							
70Cu-30Ni	5.3.3	Plate	E	Annealed				ME	0.1																	
70Cu-30Ni	5.3.3	Plate	E		MIG	70Cu-30Ni	AW	ME					0.2													
70Cu-30Ni	5.3.3	Bar	F	Annealed				ME	1	1	1															
70Cu-30Ni	5.3.3	Bar	F	Annealed				ME					2													
70Cu-30Ni	5.3.3			Annealed														TR	1,F1		1,F1		1,F1			
Cu-Be	5.4.2	Sheet	A	AT				ME								0.1										
Cu-Be	5.4.2	Sheet	B	STA				ME	1																	
Cu-Be	5.4.2	Sheet	B	1/2 H				ME	2,F1	2																
Cu-Be	5.4.2	Sheet	B	1/2 HT				ME	3	3																
Cu-Be	5.4.2	Sheet	B	1/2 HT				ME								4										
Cu-Be	5.4.2	Bar	F	STA				ME	5,F1	5																
Cu-Be	5.4.2	Bar	F	STA				ME	6	6																
Cu-Be	5.4.2	Bar	F	Cold drawn				ME	7	7																
Cu-Be	5.4.2	Bar	F	Hard drawn				ME	8																	
Cu-Be	5.4.2	Bar	F	Cold drawn, aged				ME	9,F1	9																
Cu-Be	5.4.2			Age hardened														TR	1,F1		1,F1		1,F1			
95Cu-5Sn	5.5.1	Bar	F	Cold drawn				ME	1	1	1															
95Cu-5Sn	5.5.1	Bar	F	Cold drawn				ME					2													
95Cu-5Sn	5.5.1			Annealed														TR			1,F1		1,F1			
92Cu-8Sn	5.5.2	Bar	F	Full hard				ME	1	1																
92Cu-8Sn	5.5.2			Annealed														TR				1,F1				
90Cu-10Sn	5.5.3																	TR			1,F1	1,F1				
Cu-0.2Zr	5.6.1	Bar	F	Annealed, cold drawn, aged				ME	1		1															
Cu-0.2Zr	5.6.1	Bar	F	Annealed, cold drawn, aged				ME					2													
Cu-0.4Cr-0.4Cd	5.7.1	Extrusion	F	Aged				ME	1		1															
Cu-0.4Cr-0.4Cd	5.7.1																	TR			1,F1					
Cu-Al	5.9.1	Bar	F	Annealed				ME	1	1	1															
Cu-Al	5.9.1	Bar	F	Annealed				ME					2													
Cu-Al	5.9.1			Annealed														TR	1,F1		1,F1		1,F1			
Nickel Alloys																										
K Monel (K-500)	6.1.1	Sheet	A	Aged				ME	1,F1		1															
K Monel (K-500)	6.1.1	Sheet	B	Aged				ME	2,F1		2															
K Monel (K-500)	6.1.1	Sheet	B	Aged				ME								3										

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties: Weld Properties			Mechanical Properties	Tensile			Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)	Thermal-Electrical Properties	C	C	E	S	R	MR	Magnetic Properties	
Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S N	E, G, B, ρ	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Magnetic Moment Perm., Suscept.
K Monel (K-500)	6.1.1	Sheet	B	Annealed				ME	3.1		3.1															
K Monel (K-500)	6.1.1	Sheet	B	Annealed	TIG	K Monel	AW	ME	3.2																	
K Monel (K-500)	6.1.1	Sheet	B	Annealed	TIG	K Monel	Aged	ME	3.3																	
K Monel (K-500)	6.1.1	Sheet	B	CR (1/2 H), aged				ME	3.4	3.4																
K Monel (K-500)	6.1.1	Sheet	B	CR (1/2 H), aged				ME								3.5										
K Monel (K-500)	6.1.1	Sheet	B	Aged	TIG	K Monel	AW	ME	3.6																	
K Monel (K-500)	6.1.1	Bar	F	Aged				ME	4,F1																	
K Monel (K-500)	6.1.1	Bar	F	Aged				ME					5													
K Monel (K-500)	6.1.1	Bar	F	Aged				ME								6										
K Monel (K-500)	6.1.1	Rod		Aged																					MA	1
K Monel (K-500)	6.1.1			Aged														TR			1,F1					
Inconel 600	6.2.1	Sheet	A	CR				ME	1																	
Inconel 600	6.2.1	Sheet	A	CR				ME								2										
Inconel 600	6.2.1	Bar	F	Cold drawn				ME	3,F1	3	3															
Inconel 600	6.2.1	Bar	F	Cold drawn				ME					4													
Inconel 600	6.2.1	Rod	F	ST																					MA	F1
Inconel X-750	6.2.2	Sheet	A	Annealed, aged				ME	1		1															
Inconel X-750	6.2.2	Sheet	A	Annealed, aged				ME								2										
Inconel X-750	6.2.2	Sheet	B	Annealed, aged				ME	3,F1	3	3															
Inconel X-750	6.2.2	Sheet	B	Annealed, aged				ME								4										
Inconel X-750	6.2.2	Sheet	B	Annealed	TIG	Inconel X-750	AW	ME	4.1																	
Inconel X-750	6.2.2	Sheet	B	Annealed	TIG	Inconel X-750	Aged	ME	4.2																	
Inconel X-750	6.2.2	Sheet	B	Annealed	TIG	Inconel X-750	Aged	ME	4.3																	
Inconel X-750	6.2.2	Sheet	B	Vac. ann., aged	TIG	In 69	Vac. ann., aged	ME	4.4	4.4																
Inconel X-750	6.2.2	Plate	D	Annealed, aged				ME	5		5															
Inconel X-750	6.2.2	Plate	D	Annealed, aged				ME				6														
Inconel X-750	6.2.2	Plate	D	HIP				ME	6.1		6.1				F2											
Inconel X-750	6.2.2	Plate	D	HIP/STDA				ME	6.2		6.2															
Inconel X-750	6.2.2	Bar	F	Annealed, aged				ME	7,F1																	
Inconel X-750	6.2.2	Bar		Annealed, aged				ME					8													
Inconel X-750	6.2.2	Bar	F	Complex				ME								9										
Inconel X-750	6.2.2	Bar	F	Complex				ME	10																	
Inconel X-750	6.2.2	Bar	G	Complex				ME	10.1		10.1				F3,F4											
Inconel X-750	6.2.2	Bar	H	ST				ME	10.3		10.3				F5											
Inconel X-750	6.2.2	Bar	H	STDA				ME	10.4		10.4															
Inconel X-750	6.2.2	Bar	H	ST	TIG	In 69	AW	ME	10.5		10.5															
Inconel X-750	6.2.2	Bar	H	Complex	TIG	In 69	AW	ME	10.6		10.6															
Inconel X-750	6.2.2	Bar	H	ST	TIG	In 69	ST, aged	ME	10.7		10.7															
Inconel X-750	6.2.2	Bar	H	ST	Vac., EB	None	AW	ME	10.8		10.8															
Inconel X-750	6.2.2	Bar	H	ST	Vac., EB	None	ST, aged	ME	10.9		10.9															
Inconel X-750	6.2.2	Bar	H	ST, aged	Vac., EB	None	AW	ME	10.10		10.10															
Inconel X-750	6.2.2	Forging		Aged				ME	11																	
Inconel X-750	6.2.2	Forging		Aged				ME				12														
Inconel X-750	6.2.2	Forging	G	STDA				ME	12.1																	
Inconel X-750	6.2.2	Forging	G	STDA				ME						12.2												
Inconel X-750	6.2.2			STDA														TR	1,F1		1,F1	1,F1	1,F1			
Inconel X-750	6.2.2	Rod		ST																					MA	1
Inconel X-750	6.2.2	Rod		STDA																					MA	2,3,F1
Inconel 718	6.2.3	Sheet	A	Annealed, aged				ME	1		1															
Inconel 718	6.2.3	Sheet	A	Annealed				ME	1.1		1.1															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties: Weld Properties: Process(j)	Weld Properties: Filler Alloy	Weld Properties: Post-Weld(k) Treatment	Prop Code	Tensile: Ultimate Prop	Tensile: Elastic Prop	NTS	Shear: SUS G	Impact: Charpy V	Fracture Toughness: K_{IC}, K_{IE}, J_{IC}	Fatigue: da/dN	Fatigue: S-N	Dynamic Moduli(b): E, G, B, ρ	Thermal-Electrical Properties: Prop Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties: Prop Code	Magnetic Moment Perm., Suscept
Inconel 718	6.2.3	Sheet	A	Annealed	TIG	None	Aged	ME	1.2																	
Inconel 718	6.2.3	Sheet	A	Annealed	TIG	None	Aged	ME	1.3																	
Inconel 718	6.2.3	Sheet	A	Annealed	TIG	None	Aged	ME	1.4																	
Inconel 718	6.2.3	Sheet	A	Annealed, aged	TIG	None	AW	ME	1.5		1.5															
Inconel 718	6.2.3	Sheet	A	Annealed, aged	TIG	None	Aged	ME	1.6		1.6															
Inconel 718	6.2.3	Sheet	A	20% CW				ME	1.7		1.7															
Inconel 718	6.2.3	Sheet	A	20% CW, aged				ME	1.8	1.8	1.8															
Inconel 718	6.2.3	Sheet	A	20% CW, aged	TIG	None	AW	ME	1.9		1.9															
Inconel 718	6.2.3	Sheet	A	20% CW, aged	TIG	None	Aged	ME	1.10		1.10															
Inconel 718	6.2.3	Sheet	A	30% CR, aged				ME	1.11	1.11	1.11															
Inconel 718	6.2.3	Sheet	A	30% CR, aged	TIG	None	AW	ME	1.12																	
Inconel 718	6.2.3	Sheet	A	30% CR, aged	TIG	None	Aged	ME	1.13																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	2,F1																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	3	3	3					F2										
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	4		4															
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME								5										
Inconel 718	6.2.3	Sheet	B	ST				ME	5.1	5.1	5.1															
Inconel 718	6.2.3	Sheet	B	ST	TIG	Inconel 718	AW	ME	5.2																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	5.3																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged	TIG	Inconel 718	AW	ME	5.4																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged	TIG	Inconel 718	AW	ME	5.5	5.5																
Inconel 718	6.2.3	Plate	D	Annealed, aged				ME	6																	
Inconel 718	6.2.3	Plate	D		TIG	Inconel 718	Annealed, aged	ME	6.1																	
Inconel 718	6.2.3	Plate	E	ST	TIG	Inconel 718	Aged	ME	6.2	6.2																
Inconel 718	6.2.3	Plate	E	ST	EB	None	Aged	ME	6.3	6.3					F3											
Inconel 718	6.2.3	Plate	E	ST	Plasm. ARC	Inconel 718	Aged	ME	6.4	6.4																
Inconel 718	6.2.3	Plate	E	Annealed, aged	TIG	Inconel 718	AW	ME			6.5															
Inconel 718	6.2.3	Bar	F	Annealed, aged				ME	7,F1		7					F4										
Inconel 718	6.2.3	Bar	F	Annealed, aged				ME	8	8																
Inconel 718	6.2.3	Bar	F	Annealed, aged				ME								9										
Inconel 718	6.2.3	Forging	D	Annealed, aged				ME	10,F1																	
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	11		11				F5											
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	12		12				F6											
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME					13	13												
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	14		14															
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	15		15															
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME					16													
Inconel 718	6.2.3	Forging	H	STA				ME	16.1		16.1															
Inconel 718	6.2.3	Forging	H	STA				ME						16.2												
Inconel 718	6.2.3	Forging	H	ST	TIG	Inconel 718	STA	ME	16.3		16.3															
Inconel 718	6.2.3	Forging	H	ST	TIG	Inconel 718	STA	ME						16.4												
Inconel 718	6.2.3			Annealed														TR	1,F1	1,F2	1,F1		1,F1			
Inconel 718	6.2.3	Rod		STDA																					MA	1,F1,2,F1
Inconel 706	6.2.4	Forging	H	STA				ME	1		1															
Inconel 706	6.2.4	Forging	H	STA				ME						2												
Inconel 706	6.2.4	Forging	H	ST	TIG	Inconel 718	STA	ME	3		3															
Inconel 706	6.2.4	Forging	H	ST	TIG	Inconel 718	STA	ME						4												
Inconel 706	6.2.4			STDA														TR			1,F1	1,F1				
Invar 36	6.3.1	Plate	E		TIG	Invar 36	AW	ME					0.1													
Invar 36	6.3.1	Plate	E		TIG	Invar 36	Stress Relieved	ME					0.2													
Invar 36	6.3.1	Bar	F	Cold drawn				ME	1,F1																	
Invar 36	6.3.1	Rod	F	Cold drawn				ME									2									
Invar 36	6.3.1			Annealed														TR			1,F1		1,F1			
Ni-Span C	6.3.2	Sheet	A	CR, annealed, aged				ME	1																	
Ni-Span C	6.3.2	Sheet	A	CR, annealed, aged				ME								2										
Ni-Span C	6.3.2	Bar	F	Aged, tempered				ME	3																	
Ni-Span C	6.3.2			Aged														TR			1,F1					
INCO LEA	6.3.3	Sheet	B	Annealed				ME	1																	
INCO LEA	6.3.3	Sheet	B	Annealed, aged				ME	2		2															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties														Thermal-Electrical Properties							Magnetic Properties	
					Weld Properties				Tensile			Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)		C	C	E	S	R	MR		Magnetic
Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S-N	E, G, B, ρ	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Moment Perm., Suscept
INCO LEA	6.3.3	Sheet	C	Mill annealed				ME	3																	
INCO LEA	6.3.3	Sheet	C	Annealed, aged				ME	4		4															
INCO LEA	6.3.3	Plate	D	Annealed				ME	5		5															
INCO LEA	6.3.3		D	Annealed				ME					6													
INCO LEA	6.3.3		D	Annealed, aged				ME	7		7															
INCO LEA	6.3.3		D	Annealed, aged				ME					8													
INCO LEA	6.3.3		D	Annealed, aged				ME	9		9															
INCO LEA	6.3.3		D	Annealed, aged				ME					10													
INCO LEA	6.3.3	Plate	H	STA				ME	11		11															
INCO LEA	6.3.3	Plate	H	STA				ME						11.1												
INCO LEA	6.3.3	Bar	F	Annealed, aged				ME	12		12															
INCO LEA	6.3.3																	TR	1,F1		1,F1	1,F1	1,F1			
Nickel	6.4.1	Bar	F	Hot finished				ME	1	1																
Nickel	6.4.1			Annealed														TR	1,F1		1,F1	1,F1,F2	1,F1			
"A" Nickel	6.4.2	Sheet	A	Annealed				ME	1	1																
"A" Nickel	6.4.2	Bar	F	Annealed				ME	2																	
"A" Nickel	6.4.2			Annealed														TR	1,F1		1,F1					
Alloy Steels																										
9Ni Steel	7.1.1	Sheet	A	STWQ				ME								1										
9Ni Steel	7.1.1	Sheet	B	STWQ				ME								2										
9Ni Steel	7.1.1	Sheet	B	2N+T				ME	3																	
9Ni Steel	7.1.1	Sheet	B	2N+T				ME						4												
9Ni Steel	7.1.1	Sheet	B	N+T				ME								5										
9Ni Steel	7.1.1	Plate	D	Q+T				ME	6																	
9Ni Steel	7.1.1	Plate	D	2N+T				ME	7																	
9Ni Steel	7.1.1	Plate	D	Q+T				ME					8													
9Ni Steel	7.1.1	Plate	D	Q+T	MIG	Incoweld A-covered	AW	ME					9													
9Ni Steel	7.1.1	Plate	D	Q+T	MIG	In 92	AW	ME	10																	
9Ni Steel	7.1.1	Plate	D	Q+T	Shielded MIG	Incoweld B	AW	ME	11																	
9Ni Steel	7.1.1	Plate	D	2N+T				ME					12													
9Ni Steel	7.1.1	Plate	D	2N+T	MIG	Incoweld A-covered	AW	ME					13													
9Ni Steel	7.1.1	Plate	E	Q+T				ME	14																	
9Ni Steel	7.1.1	Plate	E	Q+T				ME					15													
9Ni Steel	7.1.1	Plate	E	2N+T				ME	16																	
9Ni Steel	7.1.1	Plate	E	2N+T				ME					17													
9Ni Steel	7.1.1	Plate	E	Q+T				ME								18										
9Ni Steel	7.1.1	Plate	E	2N+T				ME								19										
9Ni Steel	7.1.1	Plate	E	2N+T	MIG	Incoweld A-covered	AW	ME					20													
9Ni Steel	7.1.1	Plate	E	2N+T	MIG	In 92	AW	ME					21													
9Ni Steel	7.1.1	Plate	G	Q+T				ME	22																	
9Ni Steel	7.1.1	Plate	G	Q+T				ME					23													
9Ni Steel	7.1.1	Plate	G	2N+T				ME	24																	
9Ni Steel	7.1.1	Plate	G	2N+T				ME					25		F2											
9Ni Steel	7.1.1	Plate	H	Q+T				ME	26																	
9Ni Steel	7.1.1	Plate	H	Q+T				ME					27	27												
9Ni Steel	7.1.1	Bar	F	2N+T				ME	28,F1																	
9Ni Steel	7.1.1	Forging	H	Q+T				ME	29																	
9Ni Steel	7.1.1	Forging	H	Q+T				ME					30													
9Ni Steel	7.1.1	Forging	H	2N+T				ME					31													
9Ni Steel	7.1.1			2N+T														TR	1,F1		1,F1					
9Ni Steel	7.1.1	Plate	H	2N+T																					MA	1
18Ni(200) Marag.	7.1.2	Plate	D	Annealed, aged				ME	1,F1	1	1															
18Ni(200) Marag.	7.1.2	Plate	D	Aged	TIG	18Ni marag.	AW	ME	1.1	1.1																
18Ni(200) Marag.	7.1.2	Plate	E	STA				ME	2,F1																	
18Ni(200) Marag.	7.1.2	Plate	E	Aged				ME	2.1																	
18Ni(200) Marag.	7.1.2	Plate	E	Annealed, aged				ME						3												
18Ni(200) Marag.	7.1.2	Plate	E	Aged	TIG	18Ni marag.	AW	ME	3.1	3.1																
18Ni(200) Marag.	7.1.2	Plate	H	Annealed, aged				ME	4																	

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

					Mechanical Properties													Thermal-Electrical Properties							Magnetic Properties	
					Weld Properties			Tensile				Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli(b)		C	C	E	S	R	MR		Magnetic Moment
Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K_{IC}, K_{IE}, J_{IC}	da/dN	S-N	E, G, B, ν	Prop Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Magneto-Resistance	Prop Code	Perm., Suscept.
18Ni(200) Marag.	7.1.2	Plate	H	Annealed, aged				ME						5												
18Ni(200) Marag.	7.1.2																	TR	1,F1							
1010 Steel	7.3.1																	TR	1,F1							
Armco Iron	7.4.1	Bar	F	Annealed				ME	1																	
Armco Iron	7.4.1			Annealed														TR	1,F1				1,F1			
5Ni Steel	7.4.3	Plate	D	QTR				ME								1										
5Ni Steel	7.4.3	Plate	D	QTR				ME					2	2												
5Ni Steel	7.4.3	Plate	D	QTR	Pulse TIG	In 92	AW	ME								3										
5Ni Steel	7.4.3	Plate	D	QTR	Shielded MIG	Incoweld B-covered	AW	ME								4										
5Ni Steel	7.4.3	Plate	E	QTR				ME	5																	
5Ni Steel	7.4.3	Plate	E	QTR				ME	F1				6													
5Ni Steel	7.4.3	Plate	E	QTR	Pulse MIG	In 92	AW	ME	7																	
5Ni Steel	7.4.3	Plate	G	QTR				ME	8	8																
5Ni Steel	7.4.3	Plate	G	QTR				ME	F2				9	9												
5Ni Steel	7.4.3	Plate	G	QTR	Pulse MIG	In 92	AW	ME	10																	
5Ni Steel	7.4.3	Plate	G	QTR	Submerged ARC	In 82	AW	ME					11													
5Ni Steel	7.4.3			Annealed														TR	1,F1							
Fe(47-50)Ni	7.4.4			Annealed														TR	1,F1	1,F2	1,F1		1,F1			
Stainless Steel																										
Type 301	8.1.1	Sheet	A	CR (1/2H)				ME	1																	
Type 301	8.1.1	Sheet	A	CR (H)				ME	2,F1		2															
Type 301	8.1.1	Sheet	A	CR (XH)				ME	3	3	3					4,F2										
Type 301	8.1.1	Sheet	A	CR	TIG	None	AW	ME	4.1																	
Type 301	8.1.1	Sheet	A	CR	TIG	None	AW	ME	4.2																	
Type 301	8.1.1	Sheet	A	CR	TIG	None	AW	ME	4.3																	
Type 301	8.1.1	Sheet	A	Cryostretched, aged				ME	4.4	4.4						F3										
Type 301	8.1.1	Sheet	B	CR (1/4 H)				ME	5		5															
Type 301	8.1.1	Sheet	B	CR (H)				ME	6		6															
Type 301	8.1.1	Sheet	B	CR (XH)				ME	7,F1	7	7															
Type 301	8.1.1	Sheet	B	CR	TIG	None	AW	ME	7.1																	
Type 301	8.1.1	Sheet	C	Cryostretched				ME	7.2	7.2																
Type 301	8.1.1	Plate	D	Annealed				ME	8		8		9													
Type 301	8.1.1	Plate	E	Unk.	MIG	Type 308	Tempered	ME	9.1		9.1															
Type 301	8.1.1	Sheet	B	Cryostretched, aged				ME								F3										
Type 301	8.1.1			Annealed														TR			1,F1					
Type 303	8.1.7	Bar	F	Annealed				ME	1				2													
Type 303	8.1.7																	TR			1,F1		1,F1			
Type 304	8.1.2	Sheet	A	CR (H)				ME	1,F1	1	1															
Type 304	8.1.2	Sheet	A	CR	TIG	None	AW	ME	1.1																	
Type 304	8.1.2	Sheet	B	Annealed				ME	2,F1		2															
Type 304	8.1.2	Plate	D	Annealed				ME	3,F1			3.1														
Type 304	8.1.2	Plate	G	Annealed				ME							(f)											
Type 304	8.1.2	Plate	H	Annealed				ME					3.2													
Type 304	8.1.2	Bar	E	Annealed				ME	4,F1		4															
Type 304	8.1.2			Annealed														TR	1,F1	1,F2	1,F1		1,F1			
Type 304	8.1.2	Rod	F	Annealed, WQ																					MA	1
Type 304L	8.1.3	Sheet	A	CR				ME	0.1		0.1															
Type 304L	8.1.3	Sheet	A	CR	TIG	None	AW	ME	0.2																	
Type 304L	8.1.3	Sheet	A	CR				ME	0.3																	
Type 304L	8.1.3	Sheet	B	Annealed				ME	1,F1		1															
Type 304L	8.1.3	Sheet	B	CR				ME	1.1																	
Type 304L	8.1.3	Sheet	B	CR				ME	1.2																	
Type 304L	8.1.3	Sheet	B	CR				ME	1.3																	

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties: Weld Properties: Process(j)	Weld Properties: Filler Alloy	Weld Properties: Post-Weld(k) Treatment	Prop Code	Tensile: Ultimate Prop	Tensile: Elastic Prop	NTS	Shear SUS	Impact Charpy V	Fracture Toughness K_{IC}, K_{IE}, J_{IC}	Fatigue da/dN	Fatigue S-N	Dynamic Moduli(b) E, G, B, ρ	Thermal-Electrical Properties: Prop Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties: Prop Code	Magnetic Moment Perm., Suscept
Type 304L	8.1.3	Plate	G	STA				ME							F3											
Type 304L	8.1.3	Plate	H	Annealed				ME					1.4													
Type 304L	8.1.3	Bar	F	Annealed				ME	2,F1	2							F2,F21									
Type 304L	8.1.3			Annealed														TP			1,F1		1,F1			
Type 304L	8.1.3	Rod	F	Annealed, WQ																					MA	1
Type 310	8.1.4	Sheet	A	CR				ME	0.1		0.1															
Type 310	8.1.4	Sheet	A	CR				ME	0.2		0.2															
Type 310	8.1.4	Sheet	A	CR				ME	0.3	0.3	0.3															
Type 310	8.1.4	Sheet	A	CR	TIG	None	AW	ME	0.4																	
Type 310	8.1.4	Sheet	A	CR				ME	0.5		0.5															
Type 310	8.1.4	Sheet	A	CR				ME	0.6		0.6															
Type 310	8.1.4	Sheet	B	Annealed				ME	1,F1		1					2										
Type 310	8.1.4	Sheet	B	CR (3/4 H)				ME	2.1	2.1																
Type 310	8.1.4	Sheet	B	CR (3/4 H)	TIG	Type 310	AW	ME	2.2	2.2																
Type 310	8.1.4	Plate	E	Annealed				ME	3		3															
Type 310	8.1.4	Plate	E	Unk.	MIG	Type 310	Tempered	ME	3.1		3.1															
Type 310	8.1.4	Plate	G	Annealed				ME	3.2						F3,F4											
Type 310	8.1.4	Plate	H	Annealed				ME					3.3													
Type 310	8.1.4	Bar	F	Annealed				ME	4,F1	4	4					F2,F2.1										
Type 310	8.1.4			Annealed														TR	1,F1,F2	1,F1	1,F1		1,F1			
Type 310	8.1.4	Rod	F	Annealed, WQ																					MA	1
Type 310S	8.1.8	Sheet	B	Annealed				ME	0.1																	
Type 310S	8.1.8	Forging	F	ST, WQ				ME	1		1				F1											
Type 310S	8.1.8	Forging	F	ST, FC				ME	2		2				F1											
Type 310S	8.1.8			Annealed														TR	1,F1			1,F1	1,F1			
Type 310S	8.1.8	Rod		ST, WQ																					MA	1,F1
Type 310S	8.1.8	Rod		ST, FC																					MA	2,F1
Type 316	8.1.5	Sheet	B	Annealed				ME	1,F1																	
Type 316	8.1.5	Sheet	B	Annealed	TIG	Type 347	AW	ME	1.1																	
Type 316	8.1.5	Plate	E	Annealed				ME	2,F1		2		2													
Type 316	8.1.5	Plate	E	Unk.	MIG	Type 316	Tempered	ME	3,1		3.1															
Type 316	8.1.5	Plate	G	Annealed										(f)												
Type 316	8.1.5	Bar	F	Annealed				ME	4,F1																	
Type 316	8.1.5			Annealed														TR			1,F1		1,F1			
Type 316	8.1.5	Rod	F	Annealed, WQ																					MA	1
Type 321	8.1.6	Sheet	B	Annealed				ME	1,F1	1	1					2										
Type 321	8.1.6	Sheet	B	Annealed	TIG	Unk.	AW	ME	2.1							F2										
Type 321	8.1.6	Plate	D	Annealed				ME	3,F1		3															
Type 321	8.1.6	Bar	F	Annealed				ME	4,F1																	
Type 321	8.1.6			Annealed														TR			1,F1		1,F1			
Type 321	8.1.6	Rod	F	Annealed, WQ																					MA	1
Type 321	8.1.6	Bar		Annealed																					MA	2
Type 321	8.1.6	Balls	F	Annealed, WQ																					MA	3
Type 347	8.1.9	Sheet	A	Annealed				ME	1	1						2,F1										
Type 347	8.1.9	Sheet	B	Annealed				ME	3							4										
Type 347	8.1.9	Plate	D	HR, annealed, pickled				ME	5			6														
Type 347	8.1.9	Plate	E	Annealed, WQ				ME	7		7		7.1													
Type 347	8.1.9	Plate	E	Unk.	MIG	Type 347	Tempered	ME	7.2		7.2															
Type 347	8.1.9	Plate	H	Annealed				ME					8													
Type 347	8.1.9	Bar	F	Annealed				ME	9		9		10													
Type 347	8.1.9																	TR	1,F1		1,F1		1,F1			
Type 410	8.1.10	Bar	F	Tempered				ME	1				2													
Type 410	8.1.10																	TR	1,F1		1,F1		1,F1			
Type 416	8.1.11	Bar	F	Tempered				ME	1				2													
Type 416	8.1.11																	TR			1,F1		1,F1			
A-286	8.2.1	Sheet	A	STA				ME	1,2,F1		1,2															
A-286	8.2.1	Sheet	B	STA				ME	3,4,F1		3,4					5										
A-286	8.2.1	Sheet	B	Annealed	TIG	A-286	AW	ME	5.1																	
A-286	8.2.1	Sheet	B	Annealed	TIG	A-286	Age Hardened	ME	5.2																	

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TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Weld Properties: Process(i)	Weld Properties: Filler Alloy	Weld Properties: Post-Weld(k) Treatment	Mechanical Properties: Prop Code	Tensile: Ultimate Prop	Tensile: Elastic Prop	Tensile: NTS	Shear: SUS G	Impact: Charpy V	Fracture Toughness: K_{IC}, K_{IE}, J_{IC}	Fatigue: da/dN	Fatigue: S-N	Dynamic Moduli(b): E, G, B, ρ	Thermal-Electrical Properties: Prop Code	C Thermal Cond.	C Magneto-Thermal Cond	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties: Prop Code	Magnetic Moment Perm., Suscept
A-286	8.2.1	Sheet	B	Age Hardened	TIG	A-286	AW	ME	5.3							F1.1										
A-286	8.2.1	Sheet	B	STA	TIG	Hastelloy W	AW	ME	5.4																	
A-286	8.2.1	Plate	D	STA				ME				6														
A-286	8.2.1	Bar	F	STA				ME	7,8,F1	8	7,8		9			F3.1										
A-286	8.2.1	Bar	F	CW, aged				ME	9.1	9.1	9.1	9.2	9.2													
A-286	8.2.1	Bar	H	STA				ME	10					11	F4											
A-286	8.2.1	Plate	G					ME							F2											
A-286	8.2.1	Bar	G	STA				ME							F3											
A-286	8.2.1			Annealed																						
A-286	8.2.1			Age Hardened														TR	1,F1				1,F1			
																		TR			1,F1					
A-286	8.2.1	Rod	F	ST																					MA	F1
Kromarc-58	8.2.2	Sheet	B	Annealed				ME	1,4,F1		4															
Kromarc-58	8.2.2	Sheet	B	Annealed, CR				ME	2,3,5,F1		5															
Kromarc-58	8.2.2	Sheet	B	Annealed, CR				ME	6,7		6,7															
Kromarc-58	8.2._	Plate	E	ST, WQ				ME	8		8			F2												
Kromarc-58	8.2.2	Plate	E	Cold worked				ME	9		9			F2												
Kromarc-58	8.2.2	Plate	E	Tempered	TIG	Kromarc-58	AW	ME	10		10															
Kromarc-58	8.2.2	Plate	E	Cold worked	TIG	Kromarc-58	AW	ME	11		11															
Kromarc-58	8.2.2	Plate	E	Unk.	TIG	Kromarc-58	AW	ME	12		12															
Kromarc-58	8.2.2			ST, Q														TR	1,F1		1,F1	1,F1	1,F1			
Kromarc-58	8.2.2	Rod		ST, Q																					MA	1
Kromarc-58	8.2.2			Cold worked																					MA	2
Kromarc-58	8.2.2	Rod		Cold worked	TIG		AW																		MA	3,4,5
Armco 21-6-9	8.2.3	Plate	G	Double annealed				ME	0.1																	
Armco 21-6-9	8.2.3	Plate	H	Annealed, WQ				ME	1				2													
Armco 21-6-9	8.2.3	Bar	F	Annealed				ME								F1										
Armco 21-6-9	8.2.3	Sheet and rod		Various																					MA	1
Armco 22-13-5	8.2.4	Plate	G	Simulated braze				ME	1					2												
Armco 22-13-5	8.2.4			Furnace brazed														TR	1,F1				1,F1			
Titanium and Titanium Alloys																										
Ti-65A	9.1.1	Bar	F	Annealed				ME	1	1	1															
Ti-65A	9.1.1	Bar	G	Annealed				ME	2(g)																	
Ti-75A	9.1.2	Sheet	A	Annealed				ME	1,F1		1															
Titanium	(h)			Annealed														TR	1,F1		1,F1	1,F1,F2	1,F1			
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	Annealed				ME	1,F1	1	1					F2										
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	20% CR				ME	1.1		1.1															
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	40% CR				ME	1.2		1.2															
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	50% CR				ME	1.3		1.3															
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	Annealed	TIG	None	AW	ME	1.4																	
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	B	Annealed				ME	2		2															
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	B	20% CR				ME	2.1		2.1															
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	B	Annealed	TIG	None	AW	ME	2.2																	
Ti-5Al-2.5Sn(N)	9.2.1	Plate	E	Annealed				ME	2.3	2.3					F6											
Ti-5Al-2.5Sn(N)	9.2.1	Bar	F	Annealed				ME	3,F1	3,F3		F5			F6											
Ti-5Al-2.5Sn(N)	9.2.1	Bar	F	Annealed				ME		F4			4													
Ti-5Al-2.5Sn(N)	9.2.1	Bar	F	Annealed				ME	5																	
Ti-5Al-2.5Sn(N)	9.2.1	Bar	H	Annealed				ME						5.1	F7											
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	Vac. annealed				ME	5.2																	
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	As forged				ME	6,F1		6															
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	As forged				ME	7		7															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Weld Properties: Process(j)	Weld Properties: Filler Alloy	Weld Properties: Post-Weld(k) Treatment	Mechanical Properties: Prop Code	Tensile: Ultimate Prop	Tensile: Elastic Prop	Tensile: NTS	Shear: SUS G	Impact: Charpy V	Fracture Toughness: K_{IC}, K_{IE}, J_{IC}	Fatigue: da/dN	Fatigue: S-N	Dynamic Moduli(b): E, G, B, ρ	Thermal-Electrical Properties: Prop Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties: Prop Code	Magnetic Moment Perm., Suscept
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	Annealed				ME	8	8	8															
Ti-5Al-2.5Sn(N)	9.2.1			Annealed														TR	1,F1			1,F1	1,F1			
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	A	Annealed				ME	1	1	1															
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	A	Annealed	TIG	None	AW	ME	1.2																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed				ME	2	2	2															
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed				ME	F1							3										
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed	TIG	Ti-5Al-2.5Sn	AW	ME	3.1	3.1																
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed	TIG	None	AW	ME	3.2		3.2															
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	C	Annealed				ME	4	4																
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	C	Annealed				ME						5												
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	C	Annealed	TIG	Ti-5Al-2.5Sn	AW	ME	5.1	5.1																
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	D	Annealed				ME	6	6																
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	D	Annealed				ME	F1			7														
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	D	Annealed	TIG	None	AW	ME	7.1																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	E	Annealed				ME	8	8																
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	E		TIG	None	AW	ME	8.1																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Bar	F	Annealed				ME	9	9	9															
Ti-5Al-2.5Sn(ELI)	9.2.2	Bar	F	Annealed				ME	F1							10										
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging	F	As forged				ME	11		11															
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging	F	As forged				ME	12		12															
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging		As forged				ME	13		13															
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging		As forged				ME						14												
Ti-5Al-2.5Sn(ELI)	9.2.2	Extrusion		As extruded				ME	15		15															
Ti-6Al-4V(ELI)	9.3.1	Sheet	A	Annealed				ME	1	1	1															
Ti-6Al-4V(ELI)	9.3.1	Sheet	B	Annealed				ME	2,F1		2															
Ti-6Al-4V(ELI)	9.3.1	Sheet	B	STA	TIG	Ti-6Al-4V	AW	ME	2.1																	
Ti-6Al-4V(ELI)	9.3.1	Plate	D	Annealed				ME	3																	
Ti-6Al-4V(ELI)	9.3.1	Plate	D	Annealed				ME						4												
Ti-6Al-4V(ELI)	9.3.1	Plate	D	Annealed	TIG	Ti-6Al-4V(ELI)	AW	ME	4.1																	
Ti-6Al-4V(ELI)	9.3.1	Bar	F	Annealed				ME	5	5																
Ti-6Al-4V(ELI)	9.3.1	Bar	F	Annealed				ME	F1				6		F2											
Ti-6Al-4V(ELI)	9.3.1	Forging	F	Annealed				ME						6.1												
Ti-6Al-4V(ELI)	9.3.1	Forging	E	As forged				ME	7,F1		7															
Ti-6Al-4V(ELI)	9.3.1			Annealed														TR	1,F1	1,F1			1,F1			
Ti-6Al-4V(N)	9.3.2	Sheet	A	STA				ME	1	1																
Ti-6Al-4V(N)	9.3.2	Sheet	A		TIG	Ti-6Al-4V	Stress relieved	ME	2																	
Ti-6Al-4V(N)	9.3.2	Sheet	B	STA				ME	3	3	3															
Ti-6Al-4V(N)	9.3.2	Sheet	B	Annealed	TIG	Ti-6Al-4V	AW	ME	4																	
Ti-6Al-4V(N)	9.3.2	Sheet	B	STA	TIG	Ti-6Al-4V	Stress relieved	ME	5																	
Ti-6Al-4V(N)	9.3.2	Plate	D	Annealed				ME	6																	
Ti-6Al-4V(N)	9.3.2	Plate	D	STA				ME	7	7																
Ti-6Al-4V(N)	9.3.2	Plate	D	Stress relieved	TIG	Ti-6Al-4V	Air relieved	ME	8																	
Ti-6Al-4V(N)	9.3.2	Plate	E	STA				ME	9																	
Ti-6Al-4V(N)	9.3.2	Bar	F	Annealed				ME	10		10															
Ti-6Al-4V(N)	9.3.2	Forging		Annealed				ME	11	11	11															
Ti-6Al-4V(N)	9.3.2			Annealed														TR	1,F1		1,F1		1,F1			
Special Metals																						F3,F4				
Niobium	10.1.1																	TR	1,F1		1,F1	1,F1,F2	1,F1			
Nb_3Sn	10.1.2																	TR	1,F1,F2							
Nb-0.2Zr	10.1.3																	TR	1,F1,F2							
Nb-2Zr	10.1.3																	TR	2,F3,F4							
Ti-7Nb	10.1.4	Bar	F	Annealed				ME	1		1															
Ti-11Nb	10.1.4	Bar	F	Annealed				ME	2		2															
Nb-Ti-Zr	10.1.4							ME	3,4																	
Nb-35Ti(+Zr)	10.1.4	Wire						ME	5																	
Ti-Nb(to 4% Nb)	10.1.4							ME	F1																	
Ti-9Nb	10.1.4																	TR			1,F1					
Ti-18Nb	10.1.4																	TR			2,F2					

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TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness[l] Code	Condition[c,d,e]	Mechanical Properties: Weld Properties: Process[j]	Weld Properties: Filler Alloy	Weld Properties: Post-Weld[k] Treatment	Tensile: Prop Code	Tensile: Ultimate Prop	Tensile: Elastic Prop	Tensile: NTS	Shear: SUS G	Impact: Charpy V	Fracture Toughness: K_{IC}, K_{IE}, J_{IC}	Fatigue: da/dN	Fatigue: S-N	Dynamic Moduli[b]: E, G, B, ρ	Thermal-Electrical Properties: Prop Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties: Prop Code	Magnetic Moment Perm., Suscept
Ti-26Nb	10.1.4																	TR			3,F3					
Ti-33Nb	10.1.4																	TR			4,F4					
Nb-45Ti	10.1.4																	TR			5,F5					
Nb-48Ti	10.1.4																	TR			6,F6					
V Ga Alloys																										
V_3Ga	10.2.1			Annealed														TR			1,F1	1,F1,F2,F3	1			
Magnesium Alloys																										
Az31B	10.3.1			Annealed														TR	1,F1							
Mg-Al-Mn alloy	10.3.1			Quenched																					MA	F1

(a) Numbers containing an "F" prefix refer to figure numbers; others refer to table numbers. Each table or figure number contains the material code followed by property code and table or figure number. The figure numbers for thermal-electrical properties contain a C (thermal or magneto-thermal conductivity), E (thermal expansion), S (specific heat), or R (electrical resistivity) following the material code.
(b) Young's, shear, bulk moduli and Poisson's ratio, respectively.
(c) HR = hot rolled; CR = cold rolled; CD = cold drawn.
(d) STA = solution treated and aged; STDA = solution treated + double aged; HIP = hot isostatic pressed; FC = furnace cooled.
(e) Q+T = quenched and tempered; 2N+T = double normalized and tempered; WQ = water quenched; QTR = quenched, tempered, + reversion annealed; Unk. = unknown.
(f) See Figure 8.1.4 – ME 3.
(g) See Figure 9.1.2 – ME 1.
(h) Exact compositions include both Ti-65A (9.1.1) and Ti-75A (9.1.2); data in handbook are on sequence of pages designated 9.1.2.
(i) See Figure 9.2.1 – ME 6.
(j) Weld Process: MIG = gas metal ARC welding; TIG = gas tungsten ARC welding; EB = electron beam welding.
(k) Post-Weld Treatment: AW = tested as welded; HT = heat treated; A = aged.
(l) Thickness codes: (pick up attached sheet)

TABLE 3.3 INDEX TO POLYMERS, FORMS, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

				Mechanical Properties												Thermal-Electrical Properties						Magnetic Properties		
					Tensile			Compress.	Shear	Impact	Fracture Toughness	Fatigue		Dynamic Moduli	Flexure		C	C	E	S	R			
Material	Mat'l Code	Form[b]	Condition	Prop. Code	Ultimate Prop.	Elastic Props.	NTS	CUS, CYS, E_c	SUS, G	Charpy V	K_{IC}, K_{IC}, J_{IC}	da/dN	S-N	E, G, B, ρ	FUS, FYS E_{f_1}, E_{f_2}	Prop. Code	Thermal Cond.	Magneto-Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity	Prop. Code	Magnetic Moment	Perm. or Suscept.
Polymers[a]			Crystallinity, %							Izod														
PE	12.1.1	Am	—													TR			1,F1	1,F1				
PCTFE	12.1.2	xt	37.6-40.0	ME	1	1			1															
PCTFE	12.1.2	xt	52.6-55.0	ME	2	2			2															
PCTFE	12.1.2	xt	57.6-60.0	ME						3														
PCTFE	12.1.2	xt	67.6-70.0	ME	4	4			4	5														
PCTFE	12.1.2	Am														TR	1,F1		1,F1	1,F1				
PTFE	12.1.3	xt	47.6-50.0	ME	1	1		1	2						1,2									
PTFE	12.1.3	xt	50.1-52.5	ME	3	3			4	4					3,4									
PTFE	12.1.3	xt	55.1-57.5	ME				5																
PTFE	12.1.3	xt	57.6-60.0	ME	6	6																		
PTFE	12.1.3	xt	65.1-67.5	ME	7	7			8						7,8									
PTFE	12.1.3	xt	67.6-70.0	ME	9			9																
PTFE	12.1.3	xt	70.1-72.5	ME						10														
PTFE	12.1.3	Am	—													TR	1,F1		1,F1	1,F1		MA		
PMM	12.2.1	Am														TR	1,F1		1,F1	1,F1				
PS	12.3.1	Am															1,F1		1,F1					
PVA	12.4.1	Am														TR	1,F1							

(a) PCTFE = polychlorotrifluoroethylene; PTFE - polytetrafluoroethylene; PE = polyethylene; PMM = polymethylmethacrylate; PS = polystyrene.
(b) xt = crystalline; Am = amorphous.

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TABLE 3.4 INDEX TO COMPOSITES, LAYUPS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISION EDITION

				Mechanical Properties																Thermal-Electrical Properties				
				Tensile[(a)]								Compression[(b)]			Shear[(c)]			Impact	Fatigue[(d)]					
Material	Mat'l Code	Lay Up	Prop Code	TUS	E_1	SE_1	E_2	TPL	Failure Strain	Poisson's Ratio	NTS	CUS	CPL	E	SUS	SPL	G	Charpy, Izod	S-N	Prop Code	Thermal Conductivity	Thermal Expansion	Specific Heat	Electrical Resistivity
Composites	11.0.0																							
Glass-Epoxy	11.1.0																							
181/EPON 828	11.1.1	Cloth	ME	1	1	1	1																	
181/EPON 828	11.1.1	Cloth	ME									2		2					F1					
181/EPON 828	11.1.1	Cloth																		TR	1	1	1	
1581/E-787(58-68R)	11.1.2	Cloth	ME	1	1				1		1													
1581/E-787(58-68R)	11.1.2	Cloth	ME									2			2									
1581/E-787(58-68R)	11.1.2	Cloth																		TR	1	1	1	
S-901/NASA Resin 2	11.1.3	Tape	ME	1	1			1	1	1		2	2	2	2		2	2						
S-901/NASA Resin 2	11.1.3	Tape																		TR		1		
Boron-Epoxy	11.2.0																							
4 Mil B/2387	11.2.1	Tape	ME	1		1		1	1	1		2	2	2	2		2		F1					
4 Mil B/2387	11.2.1	Tape																		TR	1	1	1	1
5.6 Mil B/2387	11.2.2	Tape	ME	1	1			1	1	1		2	2	2			2							
5.6 Mil B/2387	11.2.2	Tape																		TR	1			
Graphite-Epoxy	11.3.0																							
AS/NASA Resin 2	11.3.1	Tape	ME	1	1			1	1	1		2	2	2	2									
HT-S/X-904	11.3.2	Tape	ME	1	1				1	1		2		2	2									
HT-S/X-904	11.3.2	Tape																		TR	1	1	1	1
Boron-Aluminum	11.4.0																							
5.6 Mil B/6061	11.4.1	Tape	ME	1	1			1	1	1		2	2	2	2		2		F1					
5.6 Mil B/6061	11.4.1	Tape																		TR		1	1	

(a) TUS = tensile ultimate strength
E_1 = initial Young's modulus
SE_1 = strength at transition between E_1 and E_2
E_2 = secondray Young's modulus
TPL = tensile proportional limit
NTS = notched tensile strength
(b) CUS = compressive ultimate strength
CPL = compressive proportional limit
E = elastic modulus
(c) SUS = shear ultimate strength
SPL = shear proportional limit
G = shear modulus
(d) S-N Curves = plots of stress against number of cycles to failure on testing

INDEX TO MATERIAL CODES FOR SECTION 4.0

ALUMINUM AND ALUMINUM ALLOYS

MATERIALS	MATERIAL CODE
ALUMINUM	4.1.1
1099	4.1.4
1100	4.1.4
2014	4.2.1
2024	4.2.3
2219	4.2.2
5083	4.3.1
5456	4.3.2
6061	4.4.1
7005	4.5.2
7006	4.5.3
7039	4.5.1

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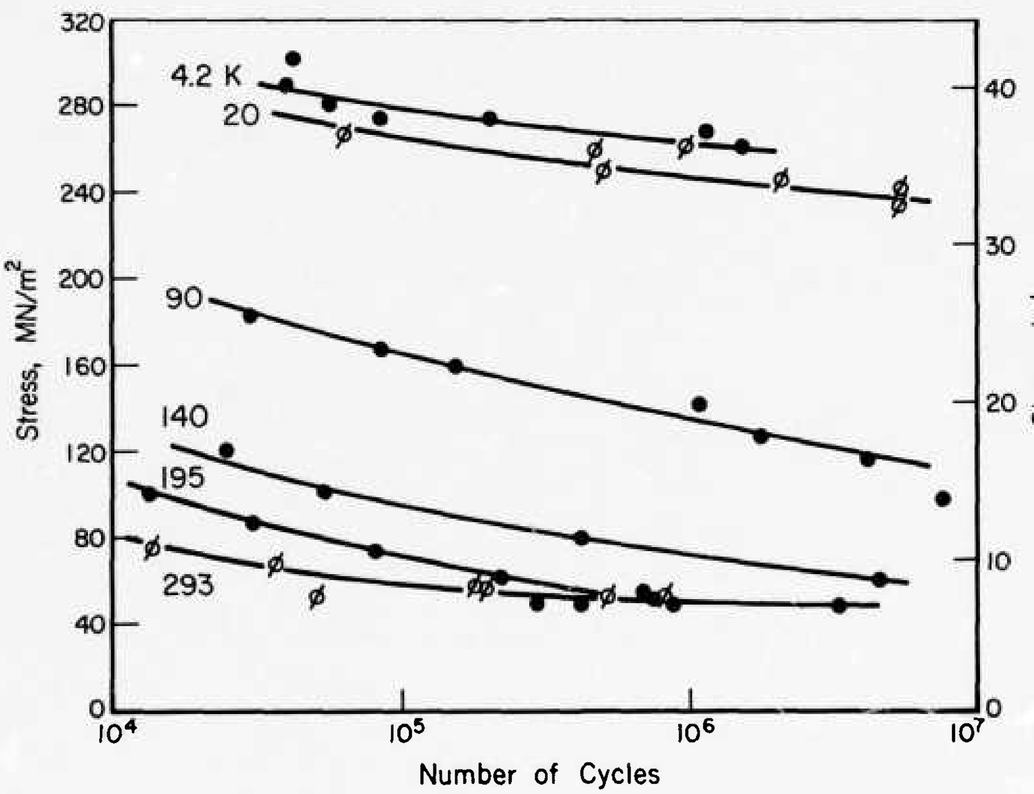

FIGURE 4.1.1-ME0.1. FATIGUE LIFE CURVES FOR AXIAL LOADING ON SPECIMENS OF 99.99% ALUMINUM ROD 0.160 cm (0.056 in.) DIAMETER AT CYCLE FREQUENCIES OF 225 HERTZ AT R = -1 [90214]

TABLE 4.1.1-TF1 Al

Alloy Designation: Aluminum

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity(1)												
RRR-30000 Watts m^{-1} K^{-1}	236	(136)	302		1230		14000		59500		96400	
Btu hr^{-1} ft^{-1} F^{-1}		(136)		(175)		(711)		(8090)		(34400)		(55700)
RRR-10000 Watts m^{-1} K^{-1}	236		302		1230		13200		39000		36500	
Btu hr^{-1} ft^{-1} F^{-1}		(136)		(175)		(711)		(7630)		(22500)		(21100)
RRR-3000 Watts m^{-1} K^{-1}	236		302		1230		11100		19100		11600	
Btu hr^{-1} ft^{-1} F^{-1}		(136)		(175)		(711)		(6420)		(11000)		(6710)
RRR-1000 Watts m^{-1} K^{-1}	236		301		1210		7020		8150		3960	
Btu hr^{-1} ft^{-1} F^{-1}		(136)		(174)		(700)		(4060)		(4710)		(2290)
RRR-300 Watts m^{-1} K^{-1}	235		299		1140		3570		2770		1200	
Btu hr^{-1} ft^{-1} F^{-1}		(136)		(173)		(659)		(2060)		(1600)		(694)
RRR-100 Watts m^{-1} K^{-1}	234		293		920		1560		963		398	
Btu hr^{-1} ft^{-1} F^{-1}		(135)		(169)		(532)		(902)		(557)		(230)
No. of Spec.												
References: 90170, 90224												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.325		-0.361		-0.368		-0.368		-0.368	
No. of Spec.	5		5		6		6		2		2	
References: 40911, 48571, 90208, 90458, 90323, 90366												
Specific Heat												
Joules kg^{-1} K^{-1}	860		480		142		8.8		1.5		0.33	
Btu lb^{-1} F^{-1}		(0.206)		(0.115)		(0.0339)		(0.00210)		(0.00036)		(0.000079)
No. of Spec.	3		3		3		2		4		5	
References: 49011, 42219, 90223, 90328												
Electrical Resistivity(1)												
RRR-30000 Ohm m	2.43×10^{-8}		4.60×10^{-9}		4.96×10^{-10}		7.02×10^{-12}		1.00×10^{-12}		8.15×10^{-13}	
Ohm circular mil ft^{-1}		(14.6)		(2.77)		(2.98×10^{-1})		(4.31×10^{-3})		(6.02×10^{-4})		(4.90×10^{-4})
RRR-10000 Ohm m	2.43×10^{-8}		4.60×10^{-9}		4.97×10^{-10}		8.64×10^{-12}		2.62×10^{-12}		2.43×10^{-12}	
Ohm circular mil ft^{-1}		(14.6)		(2.77)		(2.99×10^{-1})		(5.20×10^{-3})		(1.58×10^{-3})		(1.46×10^{-3})
RRR-3000 Ohm m	2.43×10^{-8}		4.61×10^{-9}		5.03×10^{-10}		1.43×10^{-11}		8.29×10^{-12}		8.10×10^{-12}	
Ohm circular mil ft^{-1}		(14.6)		(2.77)		(3.03×10^{-1})		(8.60×10^{-3})		(4.99×10^{-3})		(4.87×10^{-3})
RRR-1000 Ohm m	2.43×10^{-8}		4.63×10^{-9}		5.19×10^{-10}		3.05×10^{-11}		2.45×10^{-11}		2.43×10^{-11}	
Ohm circular mil ft^{-1}		(14.6)		(2.78)		(3.12×10^{-1})		(1.83×10^{-2})		(1.47×10^{-2})		(1.46×10^{-2})
RRR-300 Ohm m	2.44×10^{-8}		4.68×10^{-9}		5.76×10^{-10}		8.74×10^{-11}		8.14×10^{-11}		8.12×10^{-11}	
Ohm circular mil ft^{-1}		(14.7)		(2.82)		(3.46×10^{-1})		(5.26×10^{-2})		(4.90×10^{-2})		(4.88×10^{-2})
RRR-100 Ohm m	2.45×10^{-8}		4.85×10^{-9}		7.40×10^{-10}		2.52×10^{-10}		2.45×10^{-10}		2.45×10^{-10}	
Ohm circular mil ft^{-1}		(14.7)		(2.92)		(4.45×10^{-1})		(1.52×10^{-1})		(1.47×10^{-1})		(1.47×10^{-1})
No. of Spec.												
References: 90178, 90209, 90224, 96886												

(1) Interpolated from numerous data using theoretical correlations.

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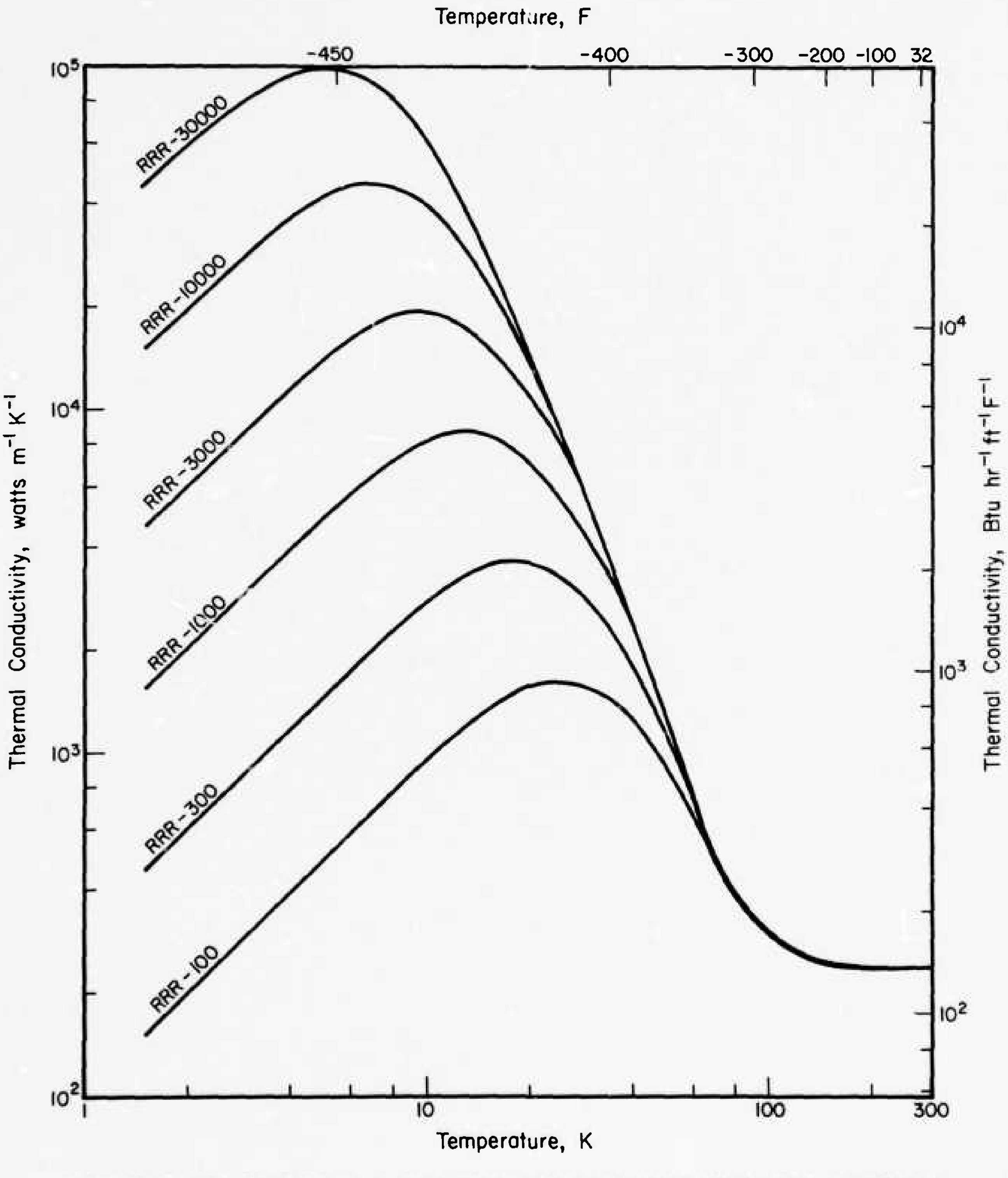


FIGURE 4.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM

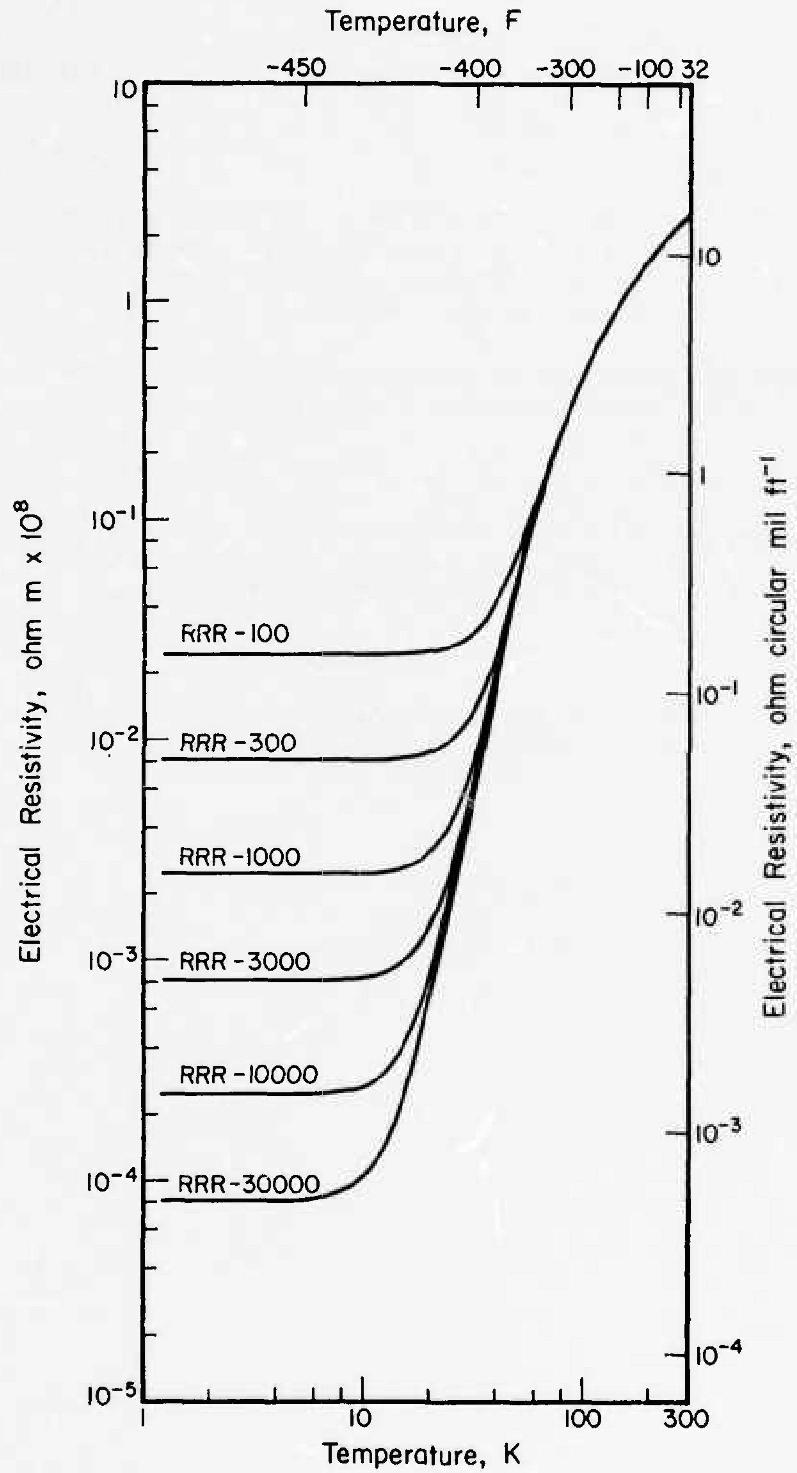
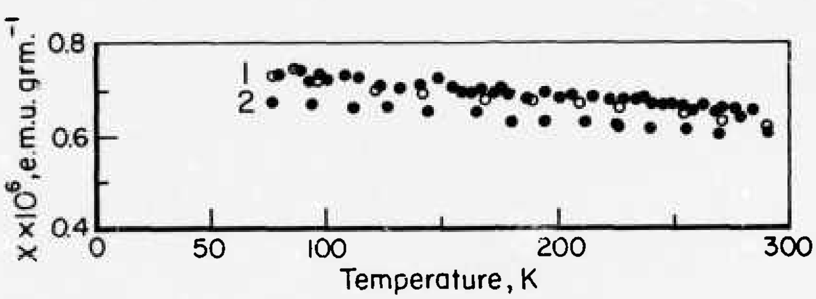


FIGURE 4.1.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM

<u>TABLE 4.1.1–MA1</u>

Alloy Designation:	High-Purity Aluminum
Specification:	Impurities, ppm: 30Mg, 5Fe, 3Si, 2Cd, 1Cu, 1Na, 1Ag
Form:	Cylindrical rod
Diameter, cm (in.):	0.4 (0.0157)
Condition:	Argon arc melted, vacuum homogenized at a temperature just below the solidus for about 7 days and quenched in ice water. Machined specimens were vacuum strain annealed for about 24 hours.

The temperature dependence of the magnetic susceptibilities (χ) of pure aluminum and an aluminum-silicon alloy is shown in the figure.



(a)

o : Pure aluminum, Taylor (1961).
1. • : Pure aluminum.
2. • : Aluminum + 0.85% silicon.

Reference: 90493

TABLE 4.1.4–ME1

Alloy Designation:	1099-H14 Aluminum
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	H14

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	91.0 (13.2)	102 (14.8)	159 (23.1)	289 (41.9)	332 (48.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	86.2 (12.5)	86.9 (12.6)	98.6 (14.3)	106 (15.4)	130 (18.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	22.6	38.4	57.2	60.5	46.7	
	Min						
RA, percent	Avg	84	83	81	79	56	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 72563

TABLE 7.1.4-ME1.1

Alloy Designation: 1100-Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 1100 Al filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate: H112; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	80.0 (11.6)		157 (22.8)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	42 (6.1)		55 (8.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	26.5		31.0			
	Min						
RA, percent	Avg	5.0		9.0			
	Min	1		1			
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	123 (17.8)		222 (32.2)			
K_t = 16	Min						
No. of Spec. (No. of Heats)		1		1			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 63362

TABLE 4.1.4–ME2

Alloy Designation: 1100-O Aluminum

Specification:
Form: Bar
Diameter: Up to 2.540 cm (1.000 in.)
Condition: Annealed (0) (ASTM Grain size 3.5)

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	93.1	(13.5)	114	(16.5)	191	(27.7)	328	(47.6)		
	Min	92.4	(13.4)	111	(16.1)	188	(27.3)	327	(47.4)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	48	(6.9)	50	(7.2)	62	(9.0)	65	(9.4)		
	Min	45	(6.5)	49	(7.1)	61	(8.9)	64	(9.3)		
Std. Deviation											
Elong, percent	Avg	45.9		50.0		56.4		54.2			
	Min	44.1		47.4		55.8		52.6			
RA, percent	Avg	88.4		85.6		81.2		60.0			
	Min	86.8		85.6		79.7		57.8			
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	2	(1)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 54986

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TABLE 4.1.4–ME3

Alloy Designation: 1100-0 Aluminum

Specification:
Form: Rod
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed (0) 620 K (650 F), FC

Testing Temperature, K (F)		297 (75)	200 (-103)	100 (-280)	"0" (-460)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Dynamic Modul:							
E, GN/m^2 (10^6psi)	Avg	69.4 (10.1)	72.8 (10.6)	75.8 (11.0)	76.9 (11.2)		
	Min						
G, GN/m^2 (10^6psi)	Avg	25.9 (3.76)	27.3 (3.96)	28.5 (4.13)	28.9 (4.14)		
	Min						
B, GN/m^2 (10^6psi)	Avg	72.4 (10.5)	73.8 (10.7)	74.9 (10.9)	75.1 (10.9)		
	Min						
Poisson's Ratio	Avg	0.340	0.336	0.331	0.329		
	Min						
No. of Spec.		1	1	1	1		
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 94206C

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

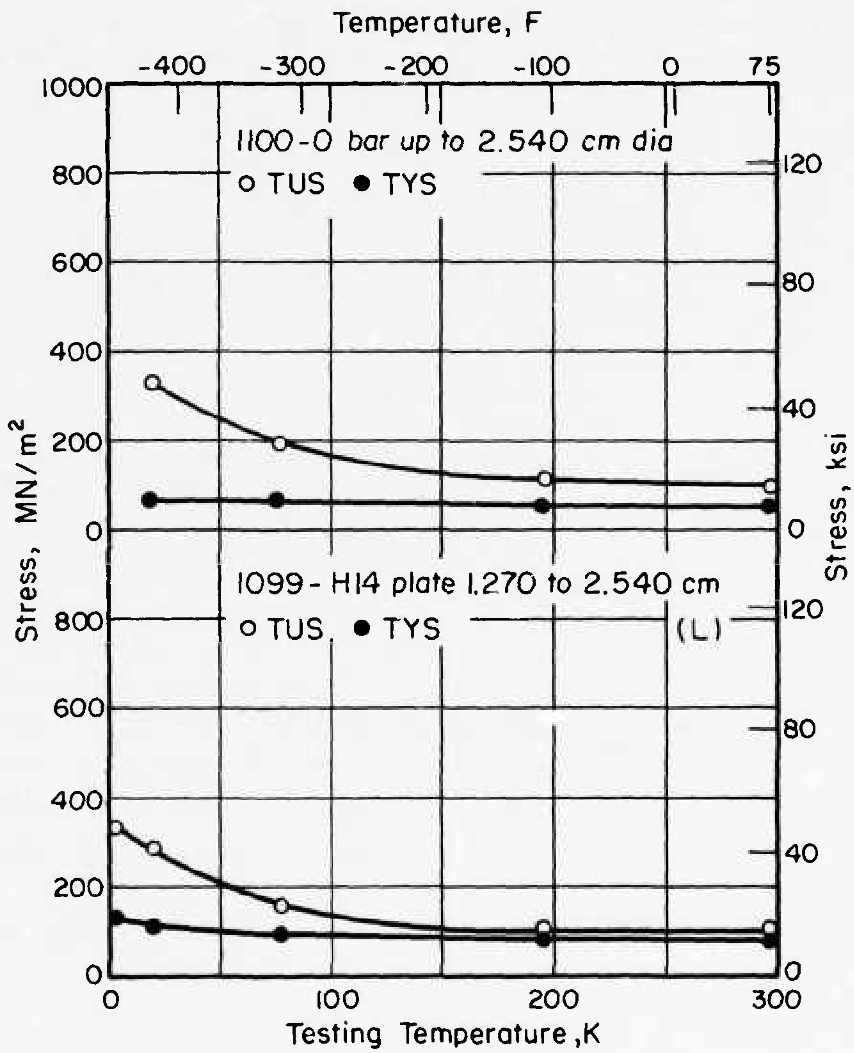

FIGURE 4.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF UNALLOYED ALUMINUM

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TABLE 4.1.4-TR1

Alloy Designation: Aluminum 1100-0

Specification:
Form:
Dimension:
Condition: Annealed (0)

Testing Temperature K (F)	H tesla	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity							
RRR-32.6 Watts m^{-1} K^{-1}		225*	310*	520*	493	270	117
Btu hr^{-1} ft^{-1} F^{-1}		(130)*	(179)*	(301)*			
RRR-14 Watts m^{-1} K^{-1}		205	228	315	225	113	45
Btu hr^{-1} ft^{-1} F^{-1}		(119)	(132)	(182)	(130)	(65)	(26.0)
No. of Spec.		1	2	2	3	3	3
References: 90111, 90225, 96888							
Thermal Expansion (T_{273} to T)							
Longitudinal							
Percent		0	-0.315	-0.355	-0.364		
No. of Spec.		1	1	1	1		
References: 48134							
Specific Heat							
Joules kg^{-1} K^{-1}							
Btu lb^{-1} F^{-1}							
No. of Spec.							
References:							
Electrical Resistivity							
RRR-32.6 Ohm m		2.67×10^{-8}	5.10×10^{-9}	1.70×10^{-9}	8.40×10^{-10}	8.20×10^{-10}	8.20×10^{-10}
Ohm circular mil ft^{-1}		(16.1)	(3.07)	(1.02)	(0.505)	(0.493)	(0.493)
RRR-14 Ohm m		2.80×10^{-8}	6.43×10^{-9}	2.87×10^{-9}	2.11×10^{-9}	2.03×10^{-9}	2.00×10^{-9}
Ohm circular mil ft^{-1}		(16.8)	(3.87)	(1.73)	(1.27)	(1.22)	(1.20)
No. of Spec.		2	2	2	2	2	2
References: 79561, 90111							
Magnetothermal Conductivity							
RRR-32.6	H tesla						
Watts m^{-1} K^{-1}	0	225*	310*	520*	493	270	117
Btu hr^{-1} ft^{-1} F^{-1}		(130)*	(179)*	(301)*	(285)	(156)	(67.6)
Watts m^{-1} K^{-1}	1	224*	260*	340*	377	247	112
Btu hr^{-1} ft^{-1} F^{-1}		(130)*	(150)*	(196)*	(218)	(143)	(64.8)
Watts m^{-1} K^{-1}	4	222*	240*	275*	273	215	98.3
Btu hr^{-1} ft^{-1} F^{-1}		(128)*	(139)*	(159)*	(158)	(124)	(56.8)
Watts m^{-1} K^{-1}	8	220*	230*	240*	243	198	81.7
Btu hr^{-1} ft^{-1} F^{-1}		(127)*	(133)*	(139)*	(141)	(114)	(47.2)
No. of Spec.		--	--	--	1	1	1
References: 96888							

* Extrapolated and Interpolated.

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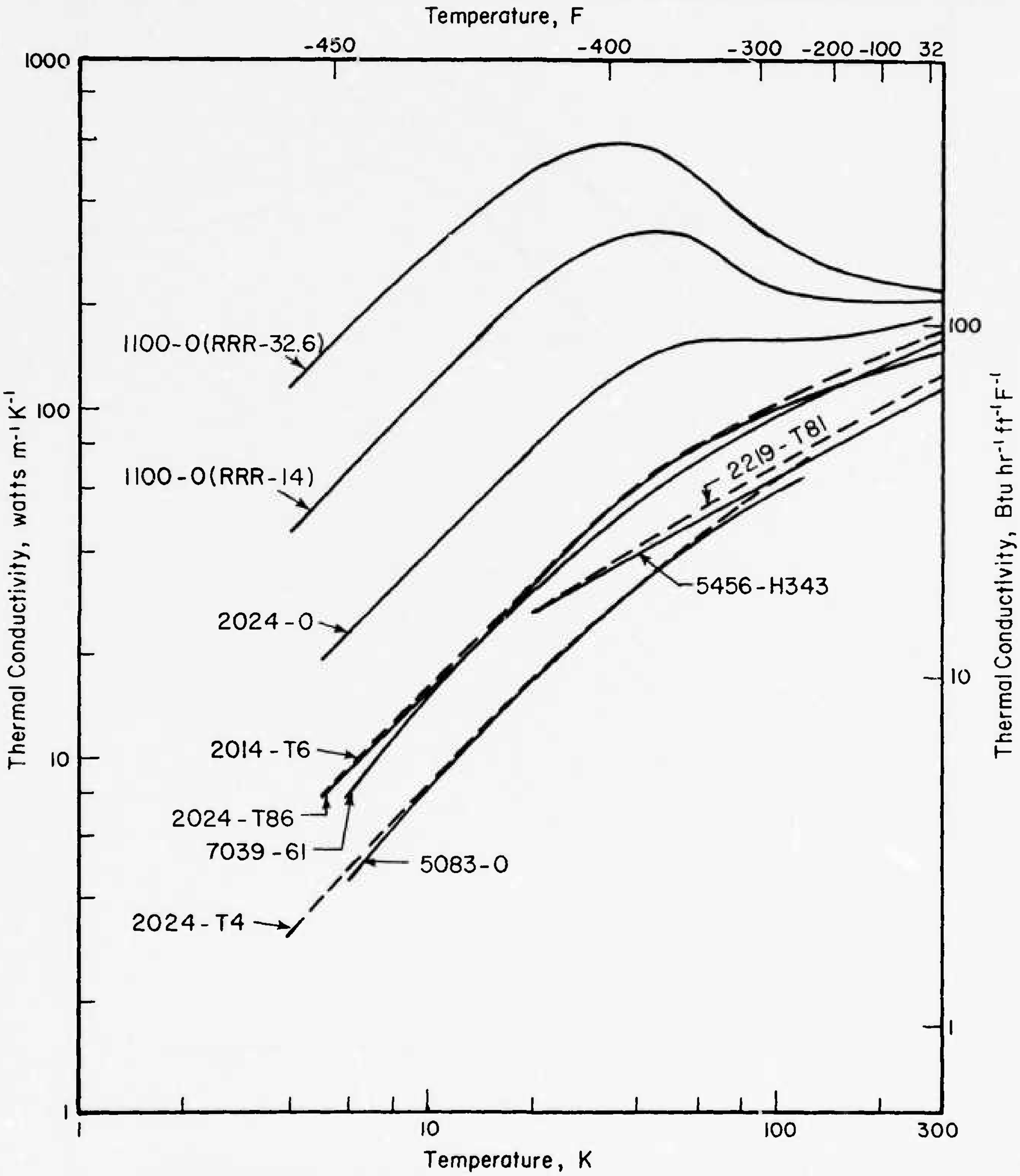

FIGURE 4.1.4-C0.1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOYS

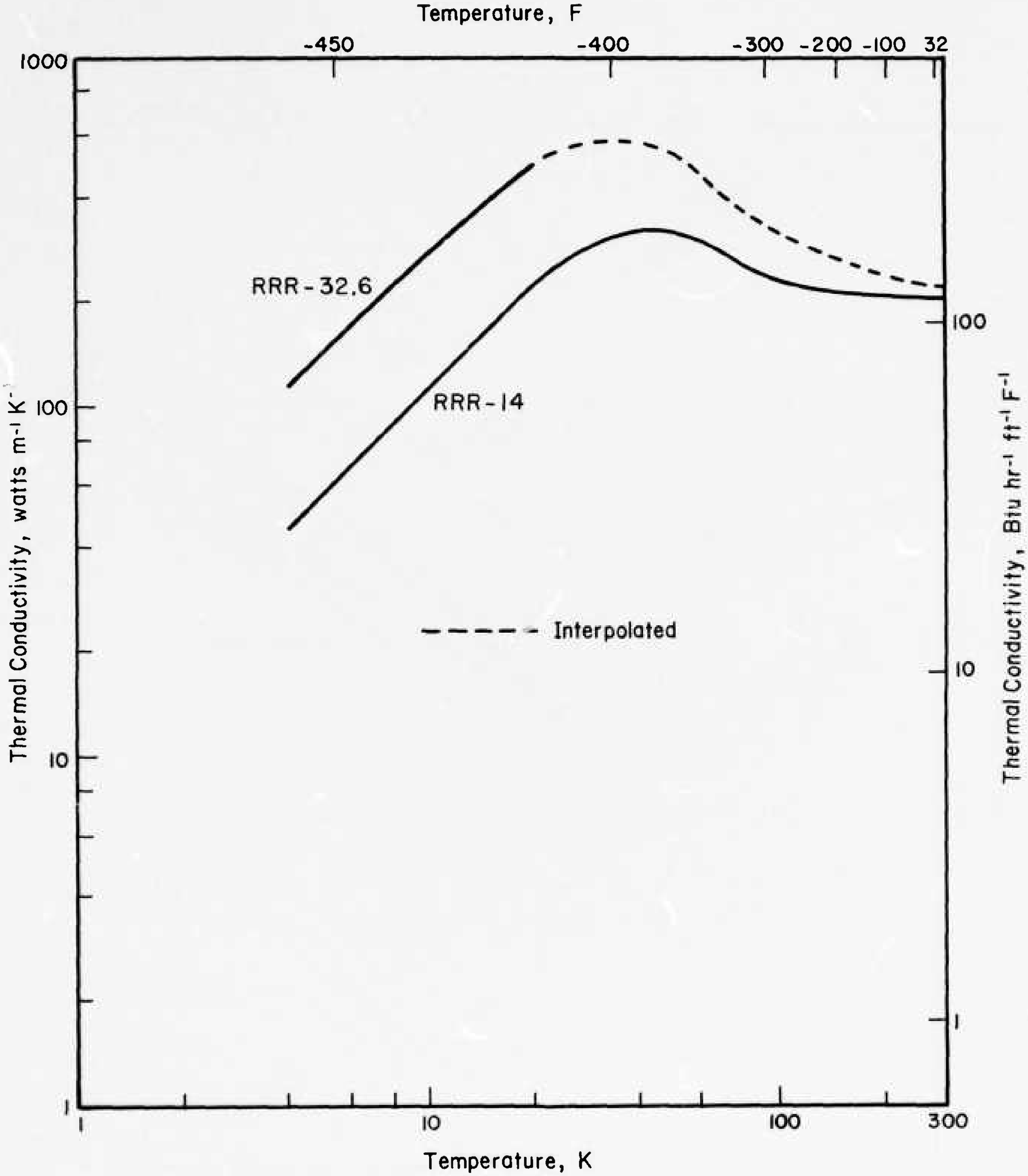

FIGURE 4.1.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

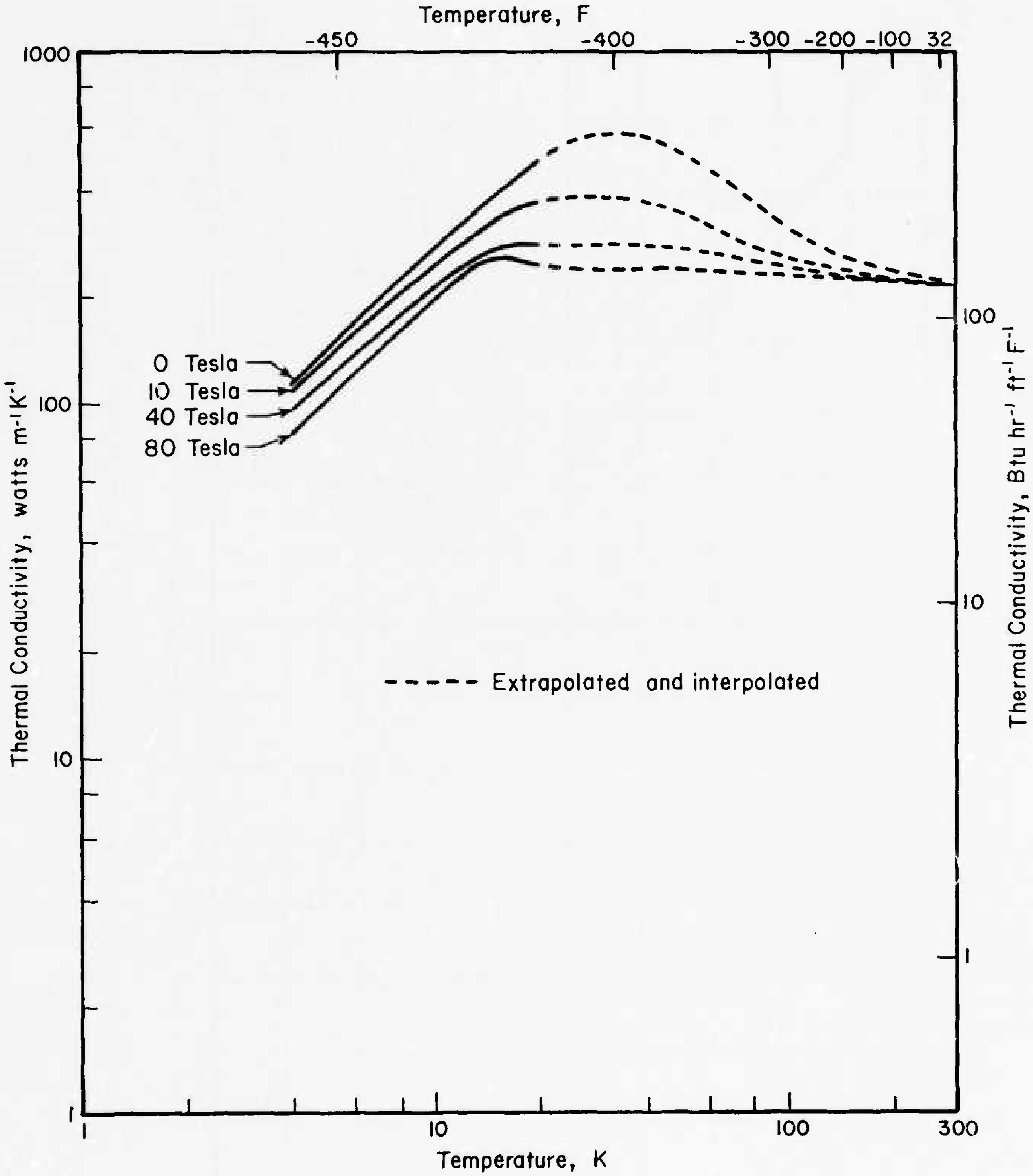

FIGURE 4.1.4-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0 AT SEVERAL MAGENTIC FIELD STRENGTHS (RRR-32.6)

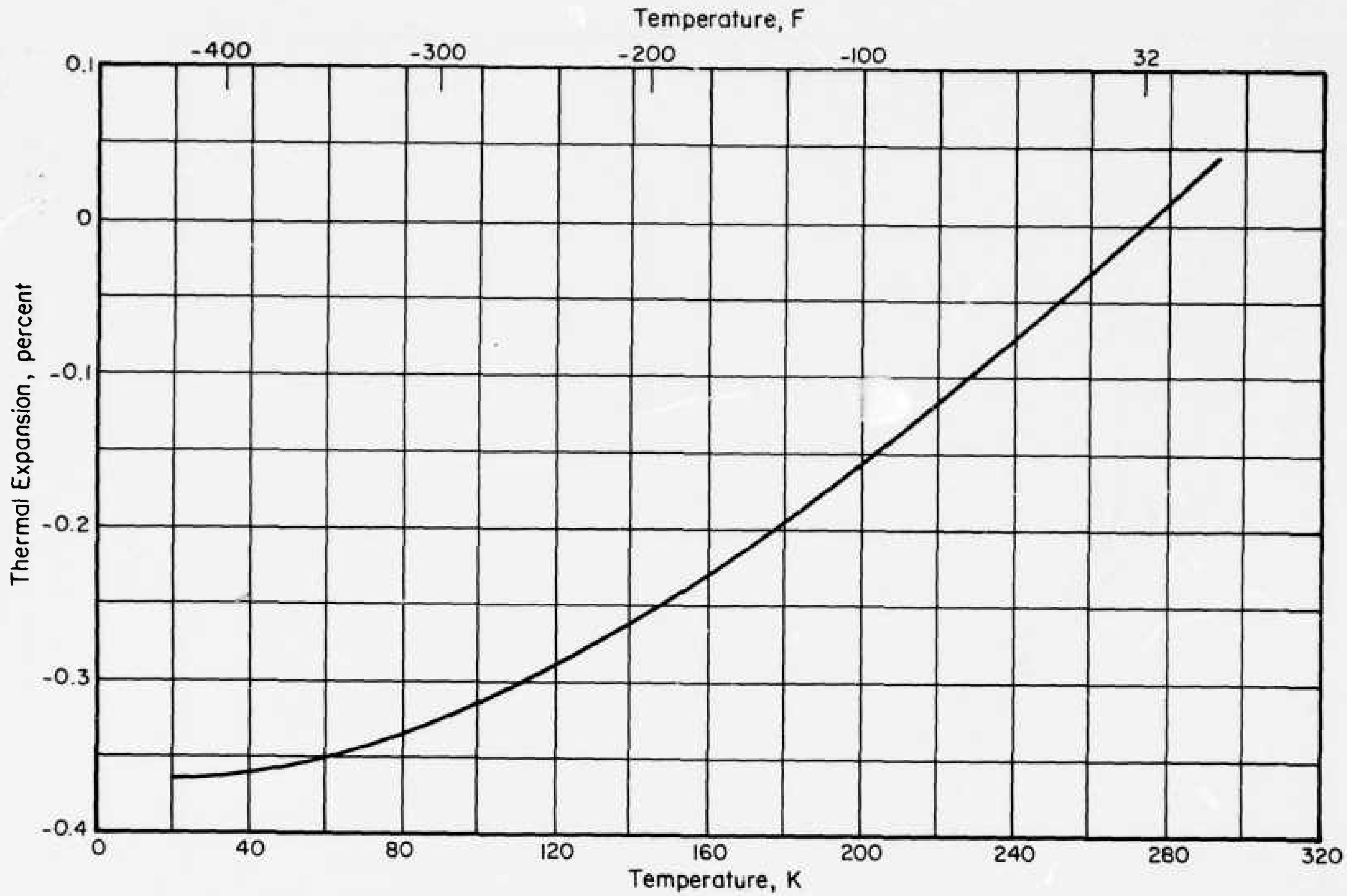

FIGURE 4.1.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

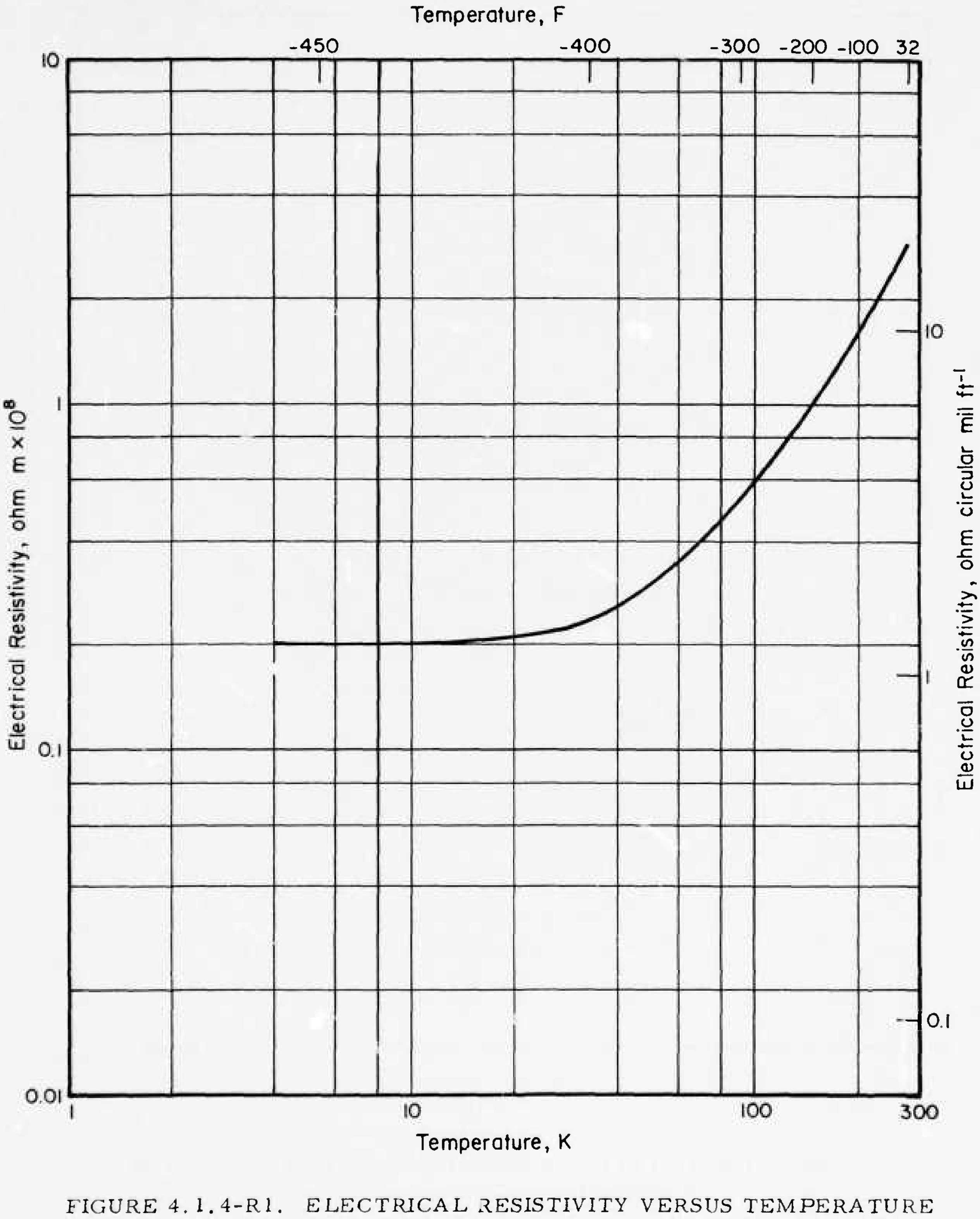

FIGURE 4.1.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

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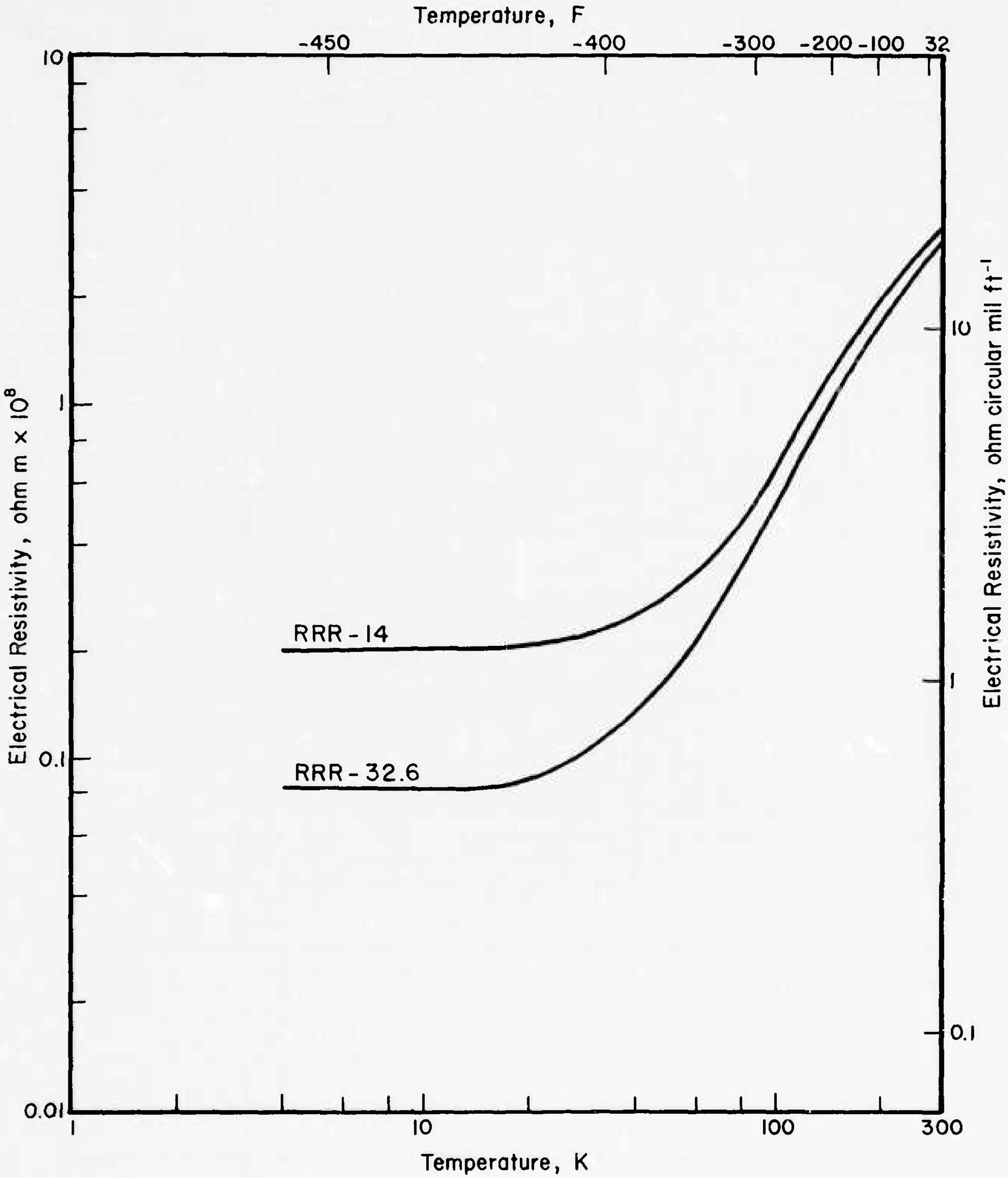

FIGURE 4.1.4-R2. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

TABLE 4.2.1-ME1

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4029A, ASTM B209
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: T6

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	483 (70.0)		562 (81.5)	681 (98.8)		
	Min				669 (97.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	427 (62.0)		510 (74.0)	543 (78.8)		
	Min				517 (75.0)		
Std. Deviation							
Elong, percent	Avg	9.0		10.8	14		
	Min				13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	476 (69.0)		559 (81.1)	674 (97.8)		
	Min				661 (95.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	421 (61.0)		485 (70.4)	520 (75.4)		
	Min				517 (75.0)		
Std. Deviation							
Elong, percent	Avg	9.0		11.3	15		
	Min				15		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 42002

TABLE 4.2.1-ME2

Alloy Designation:	2014-T6 Aluminum Alloy
Specification:	AMS-4029A, ASTM B209
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	490 (71.1)	515 (74.7)	524 (76.0)	585 (84.9)	687 (99.7)	669 (97.0)
	Min	461 (66.8)	489 (70.9)		558 (81.0)	664 (93.9)	
Std. Deviation		12.6 (1.83)	1.10 (1.59)		13.0 (1.88)	18.2 (2.64)	
TYS, MN/m^2 (ksi)	Avg	445 (64.6)	472 (68.8)	490 (71.0)	52.0 (75.4)	572 (85.0)	
	Min	413 (59.9)	447 (64.9)		496 (72.0)	534 (77.4)	
Std. Deviation		12.7 (1.87)	9.3 (1.35)		13.6 (1.97)	18.4 (2.67)	
Elong, percent	Avg	9.8	9.6	9.3	11.6	12.8	10.4
	Min	6.5	5.5		7.0	8.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		22 (11)	12 (6)	(1)	23 (11)	19 (9)	(1)
E, GN/m^2 (10^6 psi)	Avg	70.5 (10.2)	74.5 (10.8)		80.7 (11.7)	83.4 (12.1)	
	Min	66.2 (9.6)	66.9 (9.7)		74.5 (10.8)	75.8 (11.0)	
No. of Spec. (No. of Heats)		0.29	0.32		0.25	0.25	
Poisson's Ratio		0.29	0.32		0.25	0.25	
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	518 (75.1)	537 (77.9)		581 (84.2)	652 (94.5)	
K_t = 6.3	Min	511 (74.1)	528 (76.6)		549 (79.6)	581 (84.2)	
No. of Spec. (No. of Heats)		7 (2)	7 (2)		7 (2)	7 (2)	
NTS, MN/m^2 (ksi)	Avg	446 (64.7)	418 (60.7)		392 (56.9)	512 (74.2)	
K_t = 19+	Min	431 (62.5)	363 (52.6)		354 (79.6)	454 (65.8)	
No. of Spec. (No. of Heats)		6 (2)	5 (1)		6 (2)	6 (2)	
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	489 (71.0)	511 (74.1)		587 (85.1)	693 (100.5)	
	Min	457 (66.3)	485 (70.3)		550 (79.7)	648 (94.0)	
Std. Deviation		10.1 (1.46)	10.6 (1.54)		15.2 (2.20)	18.6 (2.70)	
TYS, MN/m^2 (ksi)	Avg	439 (63.7)	451 (65.4)		501 (72.6)	565 (82.0)	
	Min	403 (58.4)	429 (62.2)		460 (66.7)	505 (73.2)	
Std. Deviation		13.4 (1.95)	11.0 (1.59)		26.8 (3.88)	22.5 (3.26)	
Elong, percent	Avg	10.2	9.8		11.6	12.9	
	Min	6.5	6.5		4.5	7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (7)	11 (4)		16 (7)	15 (6)	
E, GN/m^2 (10^6 psi)	Avg	71.4 [illegible]	73.8 (10.7)		80.0 (11.6)	82.1 (11.9)	
	Min	66.9 [illegible]	66.2 (9.6)		71.0 (10.3)	71.7 (10.4)	
No. of Spec. (No. of Heats)		9 (3)	7 (2)		10 (3)	8 (3)	
Poisson's Ratio		0.27	0.32		0.26	0.23	
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	491 (71.2)	502 (72.8)		543 (78.7)	608 (88.2)	
K_t =	Min	465 (67.5)	491 (71.2)	522	522 (75.7)	564 (81.8)	
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
NTS, MN/m^2 (ksi)	Avg	412 (59.7)	372 (53.9)		430 (62.4)	478 (69.4)	
K_t =	Min	398 (57.7)	352 (51.0)		366 (53.1)	403 (58.4)	
No. of Spec. (No. of Heats)		6 (2)	5 (1)		6 (2)	6 (2)	

References: 42002, 47334, 51156, 58024, 58000, 69310, 69800, 70906, 80104, 90073, 90076, 90188, 48652

TABLE 4.2.1-ME4.1

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:
Form: Sheet-MIG welded, 4043 Al filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	319 (46.3)		420 (60.9)	414 (60.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	261 (37.8)		323 (46.8)	352 (51.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	2.8		2.0	1.2		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	296 (42.9)		315 (45.7)	351 (50.9)		
K_t = 15	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	355 (51.5)		421 (61.1)	410 (59.4)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	260 (37.7)		328 (47.6)	360 (52.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	2.0		2.1	1.2		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 90076

TABLE 4.2.1-ME4.2

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2014 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	290 (42.0)		330 (47.9)	314 (45.6)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	234 (34.0)		240 (34.8)	218 (31.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	1.2		1.0	1.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg	74.5 (10.8)		84.1 (12.2)	96.5 (14.0)		
	Min						
No. of Spec. (No. of Heats)		1					
Poisson's Ratio		0.31		0.31	--		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 69800

TABLE 4.2.1-ME4.3

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	379 (54.9)	390 (56.5)	393 (57.0)	440 (63.8)	499 (72.4)	552 (80.0)
	Min	353 (51.2)	368 (53.4)		416 (60.3)	430 (62.3)	
Std. Deviation		17.7 (2.56)	15.2 (2.21)		15.8 (2.29)	34.6 (5.02)	
TYS, MN/m² (ksi)	Avg	290 (42.1)	284 (41.2)	292 (42.4)	332 (48.1)	448 (65.0)	422 (61.2)
	Min						
Std. Deviation							
Elong, percent	Avg	2.3	1.6	1.1	1.4	1.4	2.4
	Min	1.5	1.0		0.5	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		12 (4)	9 (3)	1	12 (4)	15 (4)	1
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	404 (58.6)	401 (58.2)		453 (65.7)	509 (73.8)	
	Min	396 (57.5)	400 (58.0)		439 (63.6)	483 (70.1)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.8	1.5		1.0	1.3	
	Min	1.5	1.0		1.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48652, 53308, 58060, 90078

TABLE 4.2.1-ME4.4

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, 4043 filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	363 (52.7)	372 (54.0)	42.5 (61.7)	479 (69.4)		
	Min	352 (51.1)	363 (52.7)	406 (58.9)	471 (68.3)		
Std. Deviation		9.58 (1.39)		15.3 (2.22)			
TYS, MN/m^2 (ksi)	Avg	241 (34.9)		395 (57.3)			
	Min	234 (34.0)		392 (56.9)			
Std. Deviation							
Elong, percent	Avg	1.7	1.4	0.7	0.6		
	Min	1.0	1.0	0.5	0.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		11 (3)	5 (1)	11 (2)	5 (3)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	365 (53.0)	371 (53.8)	439 (63.7)	480 (69.6)		
	Min	357 (51.8)	365 (52.9)	425 (61.7)	463 (67.2)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.8	1.3	0.8	0.9		
	Min	1.5	1.0	0.5	0.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (3)	8 (2)	9 (3)	8 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 42002, 51156, 51527, 69310

TABLE 4.2.1-ME4.5

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 4043 filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Sheet: T62; weld metal tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal (to transverse)							
TUS, MN/m^2 (ksi)	Avg	368 (53.4)	345 (50.0)	421 (61.1)	454 (65.8)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

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TABLE 4.2.1-ME5

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4029A, ASTM B209
Form: Sheet
Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)
Condition: T6

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
					20		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	**498 (72.3)**		**590 (85.5)**	**662 (96.0)**		
	Min	487 (70.7)		578 (83.9)	630 (91.4)		
Std. Deviation		5.0 (0.72)		7.6 (1.10)	16.5 (2.40)		
TYS, MN/m^2 (ksi)	Avg	**443 (64.2)**		**505 (73.2)**	**573 (83.0)**		
	Min	418 (60.6)		483 (70.1)	550 (79.7)		
Std. Deviation		13.4 (1.95)		24.0 (3.48)	13.0 (1.89)		
Elong, percent	Avg	**9.8**		**11.6**	**9.8**		
	Min	7.0		9.0	8.8		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		65		65	24		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 69310, 79301

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TABLE 4.2.1-ME5.1

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 4043 filler
Thickness, cm (in.):	0.320 to 0.634 (0.126 to 0.249)
Condition:	Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	334 (48.5)		396 (57.4)			
	Min	324 (47.0)		384 (55.7)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	236 (34.3)		393 (57.0)			
	Min	236 (34.2)		386 (56.0)			
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		5 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 69310

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TABLE 4.2.1-ME5.2

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 716 filler
Thickness, cm (in.):	0.635 to 1.219 (0.250 to 0.449)
Condition:	Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	301 (43.7)			341 (49.5)		
	Min	294 (42.6)			336 (48.7)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	213 (30.9)			239 (34.6)		
	Min	205 (29.7)			237 (34.4)		
Std. Deviation							
Elong, percent	Avg	1.5			1.5		
	Min	1.5			1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.3

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)						
Specification:							
Form:	Plate-MIG welded, 2319 filler						
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.449)						
Condition:	Plate: T6; weld metal tested as welded						

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	283 (41.0)			344 (49.9)		
	Min	234 (34.0)			334 (48.4)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	197 (28.6)			264 (38.3)		
	Min	188 (27.3)			259 (37.6)		
Std. Deviation							
Elong, percent	Avg	2.4			1.5		
	Min	1.0			1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.4

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 4043 filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.449)
Condition:	Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	256 (37.2)			310 (45.0)		
	Min	248 (36.0)			303 (43.9)		
Std. Deviation		4.4 (0.64)					
TYS, MN/m^2 (ksi)	Avg	(23.1)			201 (29.2)		
	Min	(19.4)			171 (24.8)		
Std. Deviation		(2.95)					
Elong, percent	Avg	2.4			1.6		
	Min	2.0			1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (2)			4 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.5

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5356 filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.449)
Condition:	Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	243 (35.3)			333 (48.3)		
	Min	156 (22.6)			332 (48.1)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	177 (25.6)			205 (29.8)		
	Min	169 (24.5)			190 (27.6)		
Std. Deviation							
Elong, percent	Avg	1.9			2.5		
	Min	1.0			1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 55021

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TABLE 4.2.1-ME5.6

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 556 filler
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)
Condition: Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	225 (32.6)			323 (46.9)		
	Min	160 (23.2)			314 (45.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	(25.4)			219 (31.7)		
	Min	(24.3)			205 (29.7)		
Std. Deviation							
Elong, percent	Avg	1.6			2.0		
	Min	1.0			2.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 55021

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TABLE 4.2.1-ME6

Alloy Designation: 2014-T62 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T62

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	476 (69.0)		572 (83.0)	648 (94.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	427 (62.0)		496 (72.0)	524 (76.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	9		11			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 79816

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TABLE 4.2.1-ME7

Alloy Designation: 2014-T62 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T62

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg	44.0 (40.3)		43.1 (39.4)	53.3 (48.8)		
(From PTSC spec.)(L — S)	Min			42.0 (38.4)			
No. of Spec. (No. of Heats)		1 (1)		2 (1)	1 (1)		

References: 79816

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.2.1-ME8

Alloy Designation: 2014-T651 Aluminum Alloy

Specification: AMS-4014, ASTM B209
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T651

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	456 (66.2)		579 (84.0)	659 (95.6)		658 (95.4)
	Min	430 (62.4)					656 (95.1)
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	420 (60.9)		525 (76.1)	553 (80.2)		564 (81.8)
	Min	396 (57.5)					563 (81.7)
Std. Deviation							
Elong, percent	Avg	12.2		12.0	15.0		12.8
	Min	11.0					12.5
RA, percent	Avg	33.2		22	23		19.5
	Min	24.0					19
No. of Spec. (No. of Heats)		6 (2)		(1)	(1)		2 (1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	548 (79.5)					
K_t = 6.4	Min	529 (76.7)					
No. of Spec. (No. of Heats)		5 (1)					
NTS, MN/m^2 (ksi)	Avg	571 (82.8)		687 (99.6)	710 (103)		712 (103)
K_t = 16	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	479 (69.5)		587 (85.1)	665 (96.4)		668 (96.9)
	Min						668 (96.9)
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	432 (62.7)		513 (74.4)	534 (77.4)		585 (84.8)
	Min						
Std. Deviation							
Elong, percent	Avg	8.8		9.0	11.0		10.2
	Min						10.0
RA, percent	Avg	16		12	15		12
	Min						12
No. of Spec. (No. of Heats)		(1)		(1)	(1)		2 (1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	550 (79.8)		573 (83.1)			646 (93.7)
K_t = 16	Min						
No. of Spec. (No. of Heats)		(1)		(1)			(1)
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64373, 72563

TABLE 4.2.1-ME9

Alloy Designation:	2014-T651 Aluminum Alloy
Specification:	AMS-4014, ASTM B209
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T651

Testing Temperature, K (F)		297	(75)		77	(-320)			
Compression, Longitudinal									
CYS, MN/m^2 (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Ec, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Compression, Transverse									
CYS, MN/m^2 (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Ec, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Shear[(a)]									
SUS, MN/m^2 (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
G, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Impact, Charpy V									
Long., Nm(ft-lb)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Trans., Nm(ft-lb)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Fracture Toughness[(b)]									
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg	23.2	(21.2)		28.5	(26.1)			
	Min	22.6	(20.7)						
Orientation T – L									
No. of Spec. (No. of Heats)		5	(1)			(1)			
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg								
(From PTSC spec.)(–)	Min								
No. of Spec. (No. of Heats)									

References: 80995

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data: Notched bend specimens

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TABLE 4.2.1-ME9.1

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-TIG welded, 2319 alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 2614-T62: Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	330 (47.8)*			383 (55.5)	437 (63.4)	
	Min	326 (47.3)			376 (54.6)	432 (62.7)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	179 (26.0)			228 (33.1)	300 (43.5)	
	Min	179 (26.0)			226 (32.8)	296 (42.9)	
Std. Deviation							
Elong, percent	Avg	15			10		
	Min	14			10		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2			2	2	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 75531

* Both specimens broke in HAZ outside weld metal.

TABLE 4.2.1-ME9.2

Alloy Designation:	2014 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, 4043 alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	2014-T62: Plate; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	317 (46.0)			382 (55.4)	436 (63.2)	
	Min	303 (43.9)			366 (53.1)	419 (60.8)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	198 (28.7)			244 (35.4)	261 (37.8)	
	Min	197 (28.5)			242 (35.1)	252 (36.5)	
Std. Deviation							
Elong, percent	Avg	10			8		
	Min	6			6		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2			2	2	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 75531

TABLE 4.2.1-ME9.3

Alloy Designation:	2014-T651 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	T651

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	476 (69.0)			579 (84.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	438 (63.5)			525 (76.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	10.2			12.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	603 (87.4)			537 (103)		
K_t = 2.4	Min	521 (75.6)			619 (89.8)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg	538 (78.1)			638 (92.6)		
K_t = 13.3	Min	506 (75.6)			619 (89.8)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	479 (69.5)			587 (85.1)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	432 (62.7)			513 (74.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.8			9.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	590 (85.5)			695 (100.8)		
K_t = 2.4	Min	521 (75.6)			610 (88.4)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg	527 (76.4)			581 (84.2)		
K_t = 13.3	Min	503 (72.9)			573 (83.1)		
No. of Spec. (No. of Heats)							

References: 90188

TABLE 4.2.1-ME10

Alloy Designation: 2014-T6 Aluminum Alloy

Specification:	AMS-4121C, QQ-A-225, ASTM B211
Form:	Bar
Diameter:	Up to 2.54 (1.000)
Condition:	T6

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)			4	(-452)	
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	513	(74.4)	520	(75.4)	581	(84.2)			814	(118)	
	Min	481	(69.8)	506	(73.4)	555	(80.5)					
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	458	(66.4)	456	(66.1)	498	(72.2)			703	(102)	
	Min	415	(60.2)	443	(64.3)	474	(68.7)					
Std. Deviation												
Elong, percent	Avg	16		13		15						
	Min	15				15						
RA, percent	Avg	32.7		28.2		29.3						
	Min	32.5				27.5						
No. of Spec. (No. of Heats)		5	(2)	3	(1)	6	(2)			3	(1)	
E, GN/m^2 (10^6 psi)	Avg	72.2	(10.5)	81.4	(11.8)	79.2	(11.5)			82.0	(11.9)	
	Min	66.2	(9.6)	80.0	(11.6)	73.8	(10.7)					
No. of Spec. (No. of Heats)		5	(2)	3	(1)	6	(2)			3	(1)	
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
Elong, percent	Avg											
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 47735, 89543

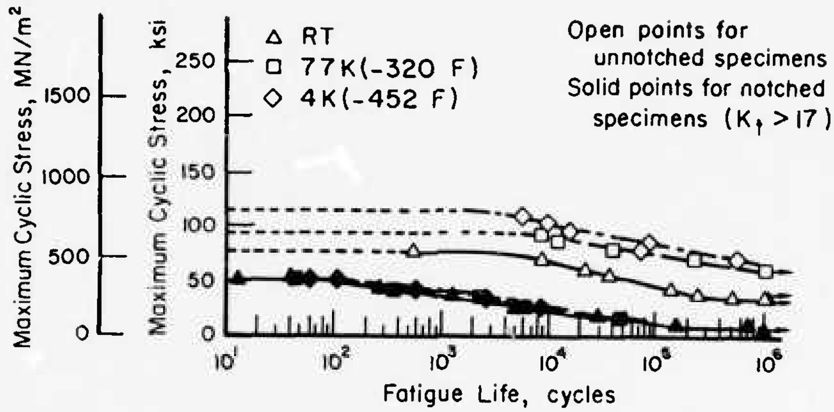

FIGURE 4.2.1-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADI[illegible] LONGITUDINAL SPECIMENS OF 2014-T6 AL[illegible]NUM ALLOY SHEET 0.152 CM (0.060 IN.) THICK AT CYCLIC FREQUENCIES OF 3.3 AND 0.27 HERTZ AT R = 0.14

Reference: 70906

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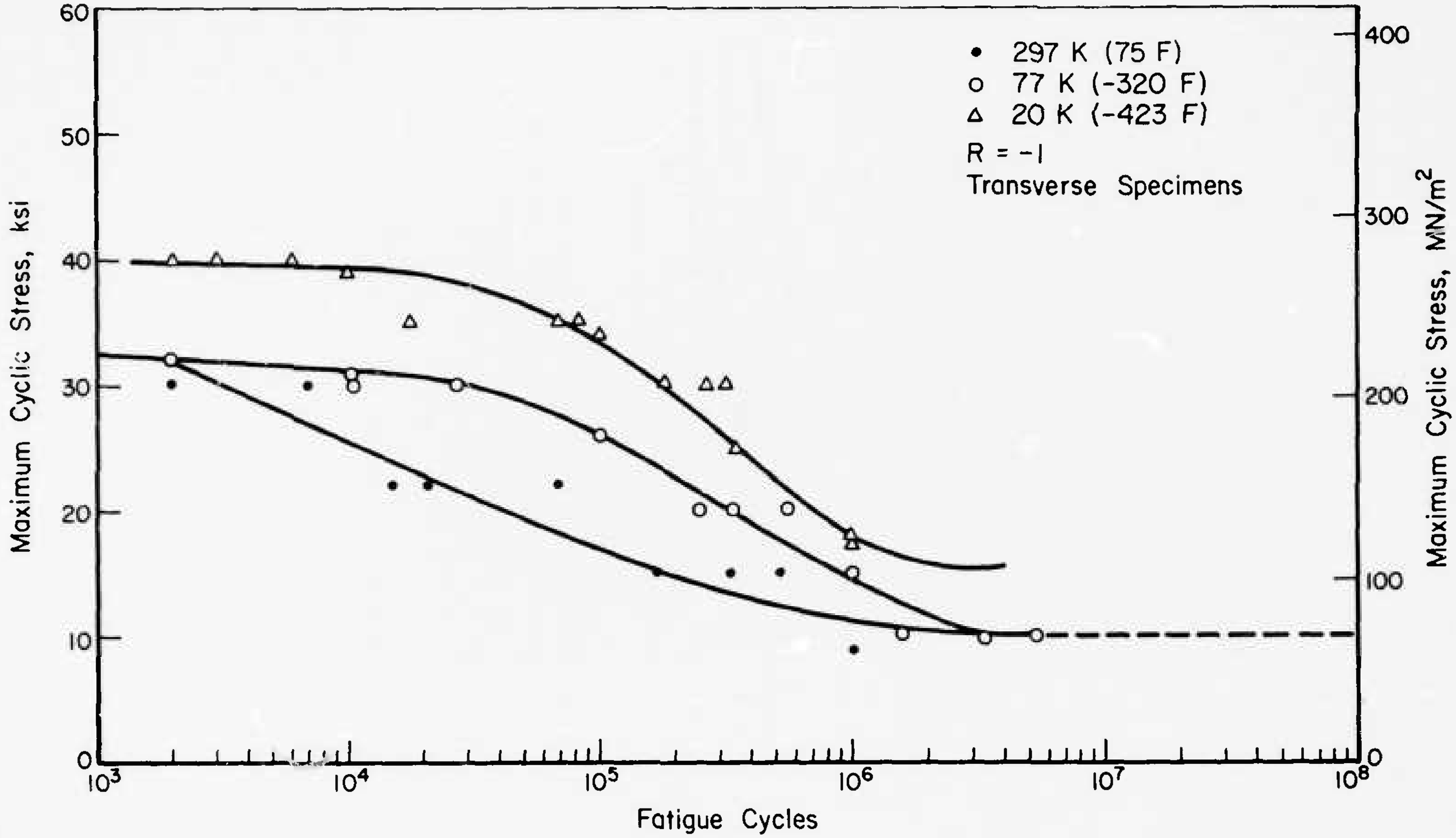

FIGURE 4.2.1-ME3. FATIGUE LIFE CURVES FOR AXIAL LOADING ON WELD METAL SPECIMENS FROM TIG-WELDED 2014-T6 ALUMINUM ALLOY 0.254 cm (0.100 in.) THICK SHEET AT R = -1

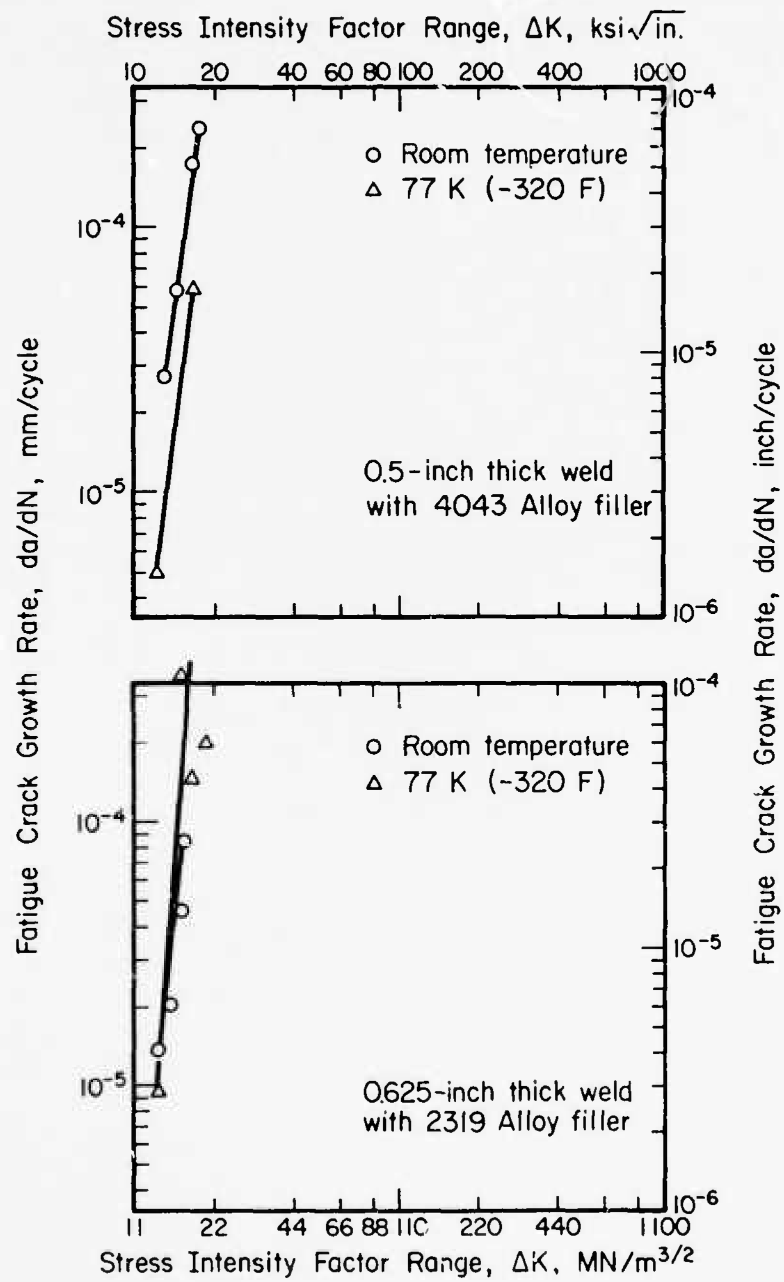

FIGURE 4.2.1-ME4. FATIGUE CRACK GROWTH RATE OF 2014-T62 ALUMINUM ALLOY PLATE, TIG-WELDED [75521] [Plate thickness 2.540 cm (1.000 in.), machined to 1.27 cm (0.500 in.) or 1.59 cm (0.625 in.) in vicinity of weld before welding]

TABLE 4.2.1-TR1

Alloy Designation: 2014-T6 Aluminum Alloy

Specification:
Form:
Dimension:
Condition: -T6

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	160	103	72	32	16	6.3
Btu hr^{-1} ft^{-1} F^{-1}	(92.5)	(59.6)	(41.6)	(18.5)	(9.25)	(3.64)
No. of Spec.	1	1	3	3	1	1
References: 90218						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.312	-0.335			
No. of Spec.	1	1	1			
References: 48571						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity (1)						
Ohm m	4.25×10^{-8}	2.15×10^{-8}	1.65×10^{-8}	1.51×10^{-8}	1.50×10^{-8}	1.50×10^{-8}
Ohm circular mil ft^{-1}	(25.6)	(12.9)	(9.92)	(9.14)	(9.02)	(9.02)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) T-651 Temper

90<

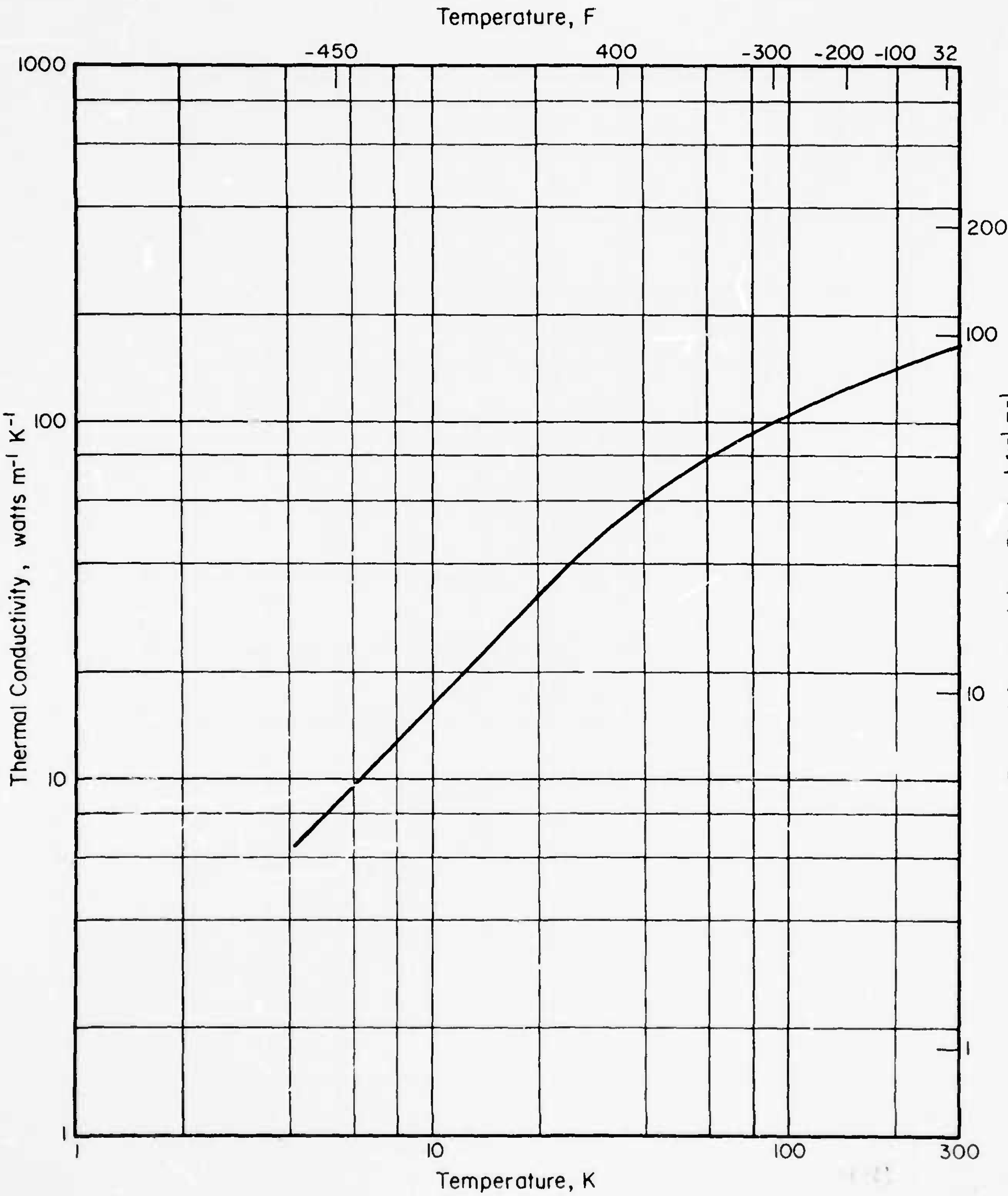

FIGURE 4.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2014-T6

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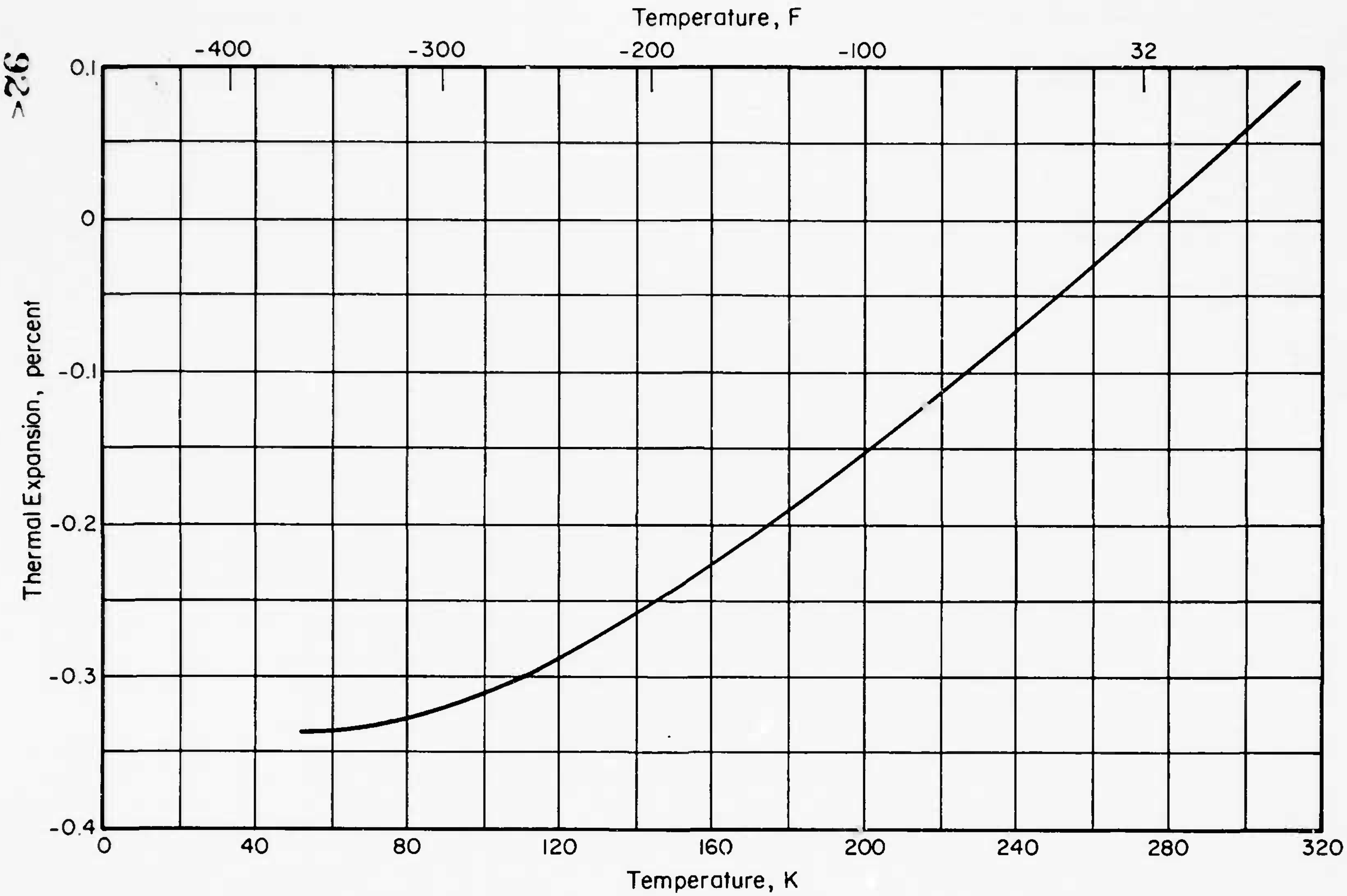

FIGURE 4.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2014-T6

TABLE 4.2.2-ME5

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: T81

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	447	(64.8)	481	(69.8)	566	(82.1)	667	(96.8)		
	Min	43.8	(63.6)	460	(66.8)	553	(80.2)	600	(87.0)		
Std. Deviation		9.03	(1.31)	14.3	(2.07)	12.3	(1.79)	27.1	(3.93)		
TYS, MN/m^2 (ksi)	Avg	348	(50.4)	374	(54.3)	423	(61.3)	476	(69.0)		
	Min	339	(49.2)	362	(52.5)	413	(59.9)	439	(63.7)		
Std. Deviation		6.69	(0.97)	10.9	(1.58)	8.13	(1.18)	20.7	(3.00)		
Elong, percent	Avg	8.8		9.1		10.7		13.4			
	Min	4.3		6.5		8.8		7.0			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		12	(5)	10	(4)	10	(4)	14	(6)		
E, GN/m^2 (10^6 psi)	Avg	68.5	(9.94)	72.4	(10.5)	80.0	(11.6)	82.0	(11.9)		
	Min	64.1	(9.3)	66.9	(9.7)	73.1	(10.6)	76.5	(11.1)		
No. of Spec. (No. of Heats)		8	(2)	7	(2)	7	(2)	5	(2)		
Poisson's Ratio		0.327		0.335		0.335		0.33			
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	427	(62.0)	459	(66.6)	514	(74.5)	565	(82.0)		
K_t = 6.3	Min	416	(60.4)	442	(64.1)	498	(72.2)	483	(70.1)		
No. of Spec. (No. of Heats)		11	(3)	7	(2)	7	(2)	9	(3)		
NTS, MN/m^2 (ksi)	Avg	363	(52.6)	351	(50.9)	414	(60.0)	467	(67.8)		
K_t = 19	Min	349	(50.6)	335	(48.6)	399	(57.9)	458	(66.4)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	450	(65.2)	488	(70.8)	563	(81.6)	673	(97.6)		
	Min	436	(63.2)	478	(69.3)	555	(80.5)	625	(90.7)		
Std. Deviation		8.07	(1.17)	7.31	(1.06)	13.2	(1.92)	22.0	(3.19)		
TYS, MN/m^2 (ksi)	Avg	341	(49.5)	367	(53.2)	414	(60.0)	466	(67.6)		
	Min	322	(46.7)	330	(47.9)	405	(58.8)	452	(65.6)		
Std. Deviation		10.5	(1.52)	14.8	(2.15)	12.7	(1.84)	10.8	(1.57)		
Elong, percent	Avg	9.7		9.6		10.1		12.1			
	Min	7.3		8.0		7.0		6.0			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		11	(4)	10	(4)	10	(4)	9	(4)		
E, GN/m^2 (10^6 psi)	Avg	69.0	(10.0)	73.8	(10.7)	79.3	(11.5)	81.4	(11.8)		
	Min	66.2	(9.6)	70.3	(10.2)	73.8	(10.7)	74.5	(10.8)		
No. of Spec. (No. of Heats)		8	(2)	7	(2)	7	(2)	5	(2)		
Poisson's Ratio		0.325		0.325		0.335		0.34			
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	432	(62.6)	449	(65.2)	514	(74.5)	590	(85.6)		
K_t = 6.3	Min	412	(60.9)	440	(63.8)	504	(73.1)	567	(82.3)		
No. of Spec. (No. of Heats)		7	(2)	7	(2)	7	(2)	7	(2)		
NTS, MN/m^2 (ksi)	Avg	363	(52.6)	322	(46.7)	392	(56.9)	423	(61.2)		
K_t = 19	Min	353	(51.2)	318	(46.1)	354	(51.4)	392	(56.8)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		

References: 42002, 51156, 51527, 56755, 61688, 90078

TABLE 4.2.2-ME6

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: T87

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	471	(68.3)	504	(73.1)	513	(74.4)	589	(85.4)	665	(99.4)
	Min	458	(66.4)	489	(70.9)			562	(81.5)	647	(93.9)
Std. Deviation		9.1	(1.32)					18.2	(2.64)	19.7	(2.85)
TYS, MN/m^2 (ksi)	Avg	388	(56.3)	410	(59.5)	427	(61.9)	474	(68.8)	501	(72.6)
	Min	372	(53.9)	379	(55.0)			421	(61.0)	469	(68.0)
Std. Deviation		8.6	(1.24)					36.5	(5.30)	4.0	(3.05)
Elong, percent	Avg	9.5		9.8		12.5		11.5		14.8	
	Min	6		6				7.0		8.5	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		24	(10)	7	(3)	3	(1)	20	(8)	20	(10)
E, GN/m^2 (10^6 psi)	Avg	73.8	(10.7)		(10.5)			80.7	(11.7)	85.5	(12.4)
	Min	70.3	(10.2)		(10.1)			73.8	(10.7)	75.2	(10.9)
No. of Spec. (No. of Heats)		5	(4)	2	(1)			6	(4)	8	(4)
Poisson's Ratio		0.30		0.24				0.28		0.27	
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	480	(69.7)	514	(74.6)			589	(85.4)	658	(95.5)
K_t = 6.3	Min	475	(68.9)	512	(74.2)			586	(85.0)	656	(95.1)
No. of Spec. (No. of Heats)		2	(1)	2	(1)			2	(1)	2	(1)
NTS, MN/m^2 (ksi)	Avg	441	(64.0)					523	(75.8)	532	(77.2)
K_t = 10	Min	437	(63.4)					519	(75.3)	508	(73.7)
No. of Spec. (No. of Heats)		2	(2)					2	(2)	2	(2)
NTS, MN/m^2 (ksi)	Avg	321	(46.5)	378	(54.8)	354	(51.3)	426	(61.8)	461	(67.0)
K_t = 22	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	473	(68.9)	506	(73.4)			598	(86.7)	701	(101.6)
	Min	452	(65.5)	483	(70.1)			571	(82.8)	648	(94.0)
Std. Deviation		12.5	(1.81)					17.2	(2.49)	23.4	(3.39)
TYS, MN/m^2 (ksi)	Avg	388	(56.3)	404	(58.6)			467	(67.8)	507	(73.5)
	Min	356	(51.7)	374	(54.3)			432	(62.7)	463	(67.2)
Std. Deviation		15.7	(2.28)					22.0	(3.20)	23.7	(3.43)
Elong, percent	Avg	9.0		7.9				9.9		12.8	
	Min	7.0		6.5				6.0		7.5	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		13	(7)	4	(2)			10	(6)	15	(8)
E, GN/m^2 (10^6 psi)	Avg	73.8	(10.7)		(11.9)			84.8	(12.3)	83.4	(12.1)
	Min	67.6	(9.8)		(11.7)			77.2	(11.2)	75.8	(11.0)
No. of Spec. (No. of Heats)		4	(3)	2	(1)			6	(3)	7	(3)
Poisson's Ratio		0.31		0.30				0.24		0.27	
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	480	(69.7)	507	(73.6)			577	(83.7)	656	(95.2)
K_t = 6.3	Min	474	(68.8)	500	(72.5)			576	(83.6)	656	(95.1)
No. of Spec. (No. of Heats)		2	(1)	2	(1)			2	(1)	2	(1)
NTS, MN/m^2 (ksi)	Avg	433	(62.8)					505	(73.3)	554	(80.3)
K_t = 10	Min	432	(62.6)					503	(72.9)	528	(76.6)
No. of Spec. (No. of Heats)		2	(2)					2	(2)	2	(2)

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References: 58024, 58060, 64658, 66103, 69310, 69759, 69800, 80104, 84319, 90078

TABLE 4.2.2-ME7

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920 A, ASTM B209
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency Hz with R = -1 and K_t = 1 No. of S-N Curves (No. of Heats)	207 (30) 1 (1)		221 (32) 1 (1)	358 (52) 1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.45		0.38	0.53		
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency Hz with R = -1 and K_t = 1 No. of S-N Curves (No. of Heats)	152 (22) 1 (1)		117- (17 to 172 25) 1 (1)	276 (40) 1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.32		0.22 to 0.29	0.40		
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Axial Loading, Notched Specimens						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency Hz with R = -1 and K_t = 3.5 No. of S-N Curves (No. of Heats)	75.8 (11.0) 1 (1)		75.8 (11.0) 1 (1)	100 (14.5) 1 (1)		
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency Hz with R = -1 and K_t = 3.5 No. of S-N Curves (No. of Heats)	51.7 (7.5) 1 (1)		48.2 (7.0) 1 (1)	55.2 (8.0) 1 (1)		
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						

References: 53308, 56753, 58024, 61996

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TABLE 4.2.2-ME7.1

Alloy Designation:	2219-T6E46
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T6E46

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	455 (66)		558 (81)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	331 (48)		393 (57)			
	Min						
Std. Deviation							
Elong, percent	Avg	12		13			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1		1			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 87195

TABLE 4.2.2-ME7.2

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Sheet-T31, weld metal tested as welded

Testing Temperature K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	320 (46.4)		381 (55.3)	446 (64.7)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

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TABLE 4.2.2-ME7.3

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet-T8, weld metal tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	296 (43.0)	319 (46.3)	351 (50.9)	427 (62.0)	510 (73.9)	518 (75.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	209 (30.3)	210 (30.4)	234 (33.9)	273 (39.6)	362 (52.5)	349 (50.6)
	Min						
Std. Deviation							
Elong, percent	Avg	2.0	2.0	2.0	2.0	3.3	2.3
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58060

TABLE 4.2.2-ME7.4

Alloy Designation:	**2219 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-MIG welded, 2319 Al filler**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**Sheet-T62; Re-heat treated and aged to T62 after welding**

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal (grain)							
TUS, MN/m^2 (ksi)	Avg	418 (60.6)	459 (66.5)	521 (75.6)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	289 (41.9)	321 (46.5)	361 (52.3)			
	Min						
Std. Deviation							
Elong, percent	Avg	7.9	9.2	8.9			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (2)	2 (1)	4 (2)			
E, GN/m^2 (10^6 psi)	Avg	79.3 (11.5)		84.8 (12.3)			
	Min	75.8 (11.0)		77.2 (11.2)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	583 (84.5)	529 (90.8)	681 (98.7)			
K_t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 87612, 90069

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TABLE 4.2.2-ME7.5

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-MIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T62 Sheet, tested as welded, heat treated [808 K (995 F) 4 hr, WQ; and aged RT-96 hr, 463 K (375 F)-36 hr]

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	415 (60.2)			508 (73.7)		
	Min	412 (59.8)			501 (72.7)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	285 (41.4)			355 (51.5)		
	Min	283 (41.0)			355 (51.5)		
Std. Deviation							
Elong, percent	Avg	7.5			8.0		
	Min	6.6			6.3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg	79.3 (11.5)			84.8 (12.3)		
	Min	75.8 (11.0)			77.2 (11.2)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 87612

TABLE 4.2.2-ME7.6

Alloy Designation:	**2219 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-TIG welded, 2319 Al filler**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**Sheet-T62, tested as welded**

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal (grain)							
TUS, MN/m^2 (ksi)	Avg	313 (45.4)		372 (54.0)	436 (63.2)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	210 (30.5)		274 (39.7)	345 (50.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	2.7		2.3	6.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)		6 (2)	6 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	326 (47.3)		390 (56.5)	408 (59.2)		
K_t = 30.3	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse (grain)							
TUS, MN/m^2 (ksi)	Avg	312 (45.2)		401 (58.1)	414 (60.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	212 (30.8)		245 (35.6)	286 (41.5)		
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	310 (44.9)		391 (56.7)	412 (59.8)		
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61996, 90076

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TABLE 4.2.2-ME7.7

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T62 sheet, welded, re-heat treated to T62, tested

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal (grain)							
TUS, MN/m^2 (ksi)	Avg	417 (60.5)		518 (75.2)	563 (81.6)		
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	300 (43.5)		357 (51.8)	403 (58.5)		
	Min						
Std Deviation							
Elong, percent	Avg	7.5		7.5	4.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	410 (59.5)		503 (73.0)	543 (78.7)		
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse (grain)							
TUS, MN/m^2 (ksi)	Avg	415 (60.2)		509 (73.8)	547 (79.4)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	295 (42.8)		352 (51.1)	394 (57.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.2		6.2	4.3		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	400 (58.0)		483 (70.0)	513 (74.4)		
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90076

TABLE 4.2.2-ME7.8

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T62 Sheet welded, re-heat treated to T62, tested

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, L to T (grain)							
TUS, MN/m^2 (ksi)	Avg	349 (50.6)	321 (46.5)	423 (61.3)	459 (66.6)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.2-ME7.9

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-MIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T81 Sheet- tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse(grain)							
TUS, MN/m^2 (ksi)	Avg	321 (46.6)	335 (48.6)	467 (67.8)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	229 (33.2)	232 (33.6)	269 (39.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	1.8	2.2	3.2			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	391 (56.7)	416 (60.3)	470 (68.2)			
K_t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME7.10

Alloy Designation:	**2219 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-MIG welded, 2319 Al filler**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**T81 Sheet- welded, aged, tested**

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse (grain)							
TUS, MN/m^2 (ksi)	Avg	334 (48.4)	348 (50.4)	463 (67.2)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	277 (40.2)	331 (48.0)	344 (49.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	1.5	0.8	2.2			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	396 (57.5)	447 (64.8)	470 (68.1)			
K_t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-7.11

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T81 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	325 (47.1)	332 (48.1)	425 (61.6)	474 (68.7)		
	Min	316 (45.8)	316 (45.9)	405 (58.7)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.4	3.3	2.5	1.7		
	Min	2.0	2.5	2.0	1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)	8 (2)	11 (3)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	328 (47.5)	313 (45.4)	397 (57.6)	462 (67.0)		
	Min	313 (45.4)	310 (44.9)	388 (56.3)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.0	1.7	2.5	0.8		
	Min	2.0	1.0	2.5	0.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	8 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 51156, 51527, 90078

TABLE 4.2.2-7.12

Alloy Designation:	**2219 Alumnium Alloy (Weld Metal)**
Specification:	
Form:	**Sheet- TIG welded, 2319 Al filler**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**T81 Sheet, tested as welded**

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, L to T (grain)							
TUS, MN/m^2 (ksi)	**Avg**	324 (47.0)		405 (58.8)	451 (65.4)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	**Avg**						
	Min						
Std. Deviation							
Elong, percent	**Avg**						
	Min						
RA, percent	**Avg**						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	**Avg**						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	**Avg**						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	**Avg**						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	**Avg**						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	**Avg**						
	Min						
Std. Deviation							
Elong, percent	**Avg**						
	Min						
RA, percent	**Avg**						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	**Avg**						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	**Avg**						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	**Avg**						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.2-ME7.13

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T81 Sheet, welded, re-heat treated to T81, tested

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, L to T (grain)							
TUS, MN/m^2 (ksi)	Avg	339 (49.1)	328 (47.5)	428 (62.1)	449 (65.1)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.2-ME7.14

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-MIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T87 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	319 (46.2)	334 (48.5)	463 (67.2)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	219 (31.8)	23.9 (34.6)	256 (37.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	2.2	2.0	3.5			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	368 (53.4)	445 (64.6)	476 (69.1)			
K_t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME7.15

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-MIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T87 Sheet, welded, aged, tested

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	363 (52.6)	376 (54.6)	482 (69.9)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	279 (40.4)	281 (40.7)	310 (45.0)			
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	2.0	1.5	2.0			
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	381 (55.2)	414 (60.1)	445 (64.6)			
K_t = 23.4	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

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TABLE 4.2.2-ME7.16

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T87 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	312 (45.3)	341 (49.5)	402 (58.3)	482 (69.9)		
	Min	258 (37.4)	334 (48.5)	361 (52.3)	441 (64.0)		
Std. Deviation		35.3 (5.12)		30.8 (4.47)	30.3 (4.40)		
TYS, MN/m^2 (ksi)	Avg	202 (29.3)		286 (41.5)	276 (40.1)		
	Min	172 (25.0)		200 (29.0)	184 (26.7)		
Std. Deviation		20.1 (2.93)		77.9 (11.3)			
Elong, percent	Avg	2.4	3.7	3.2	2.1		
	Min	1.3	3.0	2.0	0.5		
RA, percent	Avg	28.5		23.2			
	Min						
No. of Spec. (No. of Heats)		21 (7)	3 (1)	18 (6)	16 (5)		
E, GN/m^2 (10^6 psi)	Avg	67 (9.7)		93.8 (13.6)	102 (14.8)		
	Min	61 (8.9)		1	1		
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.21		0.26	0.29		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 53308, 69310, 69800, 84318, 84319, 89983, 90078

TABLE 4.2.2-ME7.17

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 2319 Alloy filler
Thickness, cm (in.):	0.320 to 0.634 (0.126 to 0.249)
Condition:	T87 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	312 (45.3)			411 (59.6)		
	Min	310 (45.0)			407 (59.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	184 (26.7)			338 (49.0)		
	Min	178 (25.8)			335 (48.6)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			5 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 69310

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TABLE 4.2.2-ME8

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Plate
Thickness, cm (in.): 0.635 to 1.27 (0.250 to 0.499)
Condition: T81

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	442 (64.1)			652 (94.6)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	343 (49.8)			483 (70.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.5			13		
	Min						
RA, percent	Avg	20.5			25.6		
	Min				25.1		
No. of Spec. (No. of Heats)		1 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	420 (61)			483 (70.1)		
K_t = 6.3	Min	394 (57.1)			480 (69.7)		
No. of Spec. (No. of Heats)		4 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66080

TABLE 4.2.2-ME9

Alloy Designation:	2219-T81 Aluminum Alloy
Specification:	MIL-A-8920 A, ASTM B209
Form:	Plate
Thickness, cm (in.):	0.635 to 1.27 (0.250 to 0.499)
Condition:	T81

Testing Temperature, K (F)		297 (75)			20 (-423)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg	256 (37.2)			498 (72.3)		
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$($ksi\sqrt{in.}$)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$($ksi\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 56754

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.2.2-ME10

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: T87

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	463 (67.2)		578 (83.8)	671 (97.3)		
	Min	458 (66.4)		576 (83.5)	665 (96.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	380 (55.1)		458 (66.4)	487 (70.6)		
	Min	376 (54.5)		454 (65.9)	485 (70.3)		
Std. Deviation							
Elong, percent	Avg	10.8		12.5	14.2		
	Min	10.7		12.2	12.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	454 (65.8)		547 (79.4)	578 (83.8)		
K_t = 10	Min	452 (65.6)		540 (78.3)	574 (83.2)		
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	467 (67.8)		590 (85.6)	684 (99.2)		
	Min	464 (67.3)		585 (84.9)	678 (98.4)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	378 (54.8)		454 (65.9)	480 (69.7)		
	Min	374 (54.3)		449 (65.1)	476 (69.0)		
Std. Deviation							
Elong, percent	Avg	10.4		11.6	14.6		
	Min	9.8		11.2	14.3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	448 (65.0)		544 (78.9)	567 (82.2)		
K_t = 10	Min	447 (64.8)		540 (78.3)	564 (81.8)		
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64658

TABLE 4.2.2-ME10.1

Alloy Designation:	2219-T6E46
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.449)
Condition:	T6E46, Aged from T42 condition at 450 K (350 F), 12 hr.

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	432 (62.7)	450 (65.3)	539 (78.2)	625 (90.6)		
	Min	430 (62.4)	429 (62.2)	517 (75.0)	580 (84.1)		
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	312 (45.3)	330 (47.8)	370 (53.6)	405 (58.8)		
	Min	309 (44.9)	303 (44.0)	361 (52.4)	391 (56.7)		
Std. Deviation							
Elong, percent	Avg	16.5	21.7	24.3	(24.0)		
	Min	14.0	21.0	22.0	(21.0)		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	4 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg	71.0 (10.3)	75.2 (10.9)	80.7 (11.7)	77.9 (11.3)		
	Min	64 (9.3)	73.1 (10.6)	77.9 (11.3)	73.1 (10.6)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	4 (1)	3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	453 (65.7)	479 (69.5)	549 (79.6)	655 (95.0)		
	Min	449 (65.1)	463 (67.2)	543 (78.7)	627 (90.9)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	332 (48.1)	350 (50.7)	394 (57.1)	435 (63.1)		
	Min	325 (47.2)	344 (49.9)	389 (56.4)	430 (62.4)		
Std. Deviation							
Elong, percent	Avg	14.3	16.5	16.8	16.5		
	Min	14.0	15.0	16.0	16.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg	75.8 (11.0)	76.5 (11.1)	80.0 (11.6)	78.6 (11.4)		
	Min	74.5 (10.8)	69.0 (10.0)	76.5 (11.1)	67.6 (9.8)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME10.2

Alloy Designation:	**2219 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Plate-TIG welded, 2319 Alloy filler**
Thickness, cm (in.):	**0.635 to 1.269 (0.250 to 0.449)**
Condition:	**2219-0 Plate: tested as welded and heat treated to T6E46 [T42 + 450 K (350 F), 12 hr.**

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	473 (68.6)			522 (75.7)	652 (94.6)	
	Min	470 (68.2)			500 (72.5)	613 (88.9)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	348 (50.4)			380 (55.1)	452 (65.5)	
	Min	343 (49.8)			378 (54.8)	431 (62.5)	
Std. Deviation							
Elong, percent	Avg	11.0			10.5	10.9	
	Min	10.5			7.5	7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	4 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58761

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TABLE 4.2.2-ME11

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Plate
Thickness, cm (in.): 1.27 to 2.54 (0.500 to 1.000)
Condition: T87

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal													
TUS, MN/m^2 (ksi)	Avg	460	(66.8)	496	(72.0)	513	(74.4)	578	(83.8)	676	(98.1)	674	(97.8)
	Min	432	(62.6)	483	(70.1)	507	(73.5)	559	(81.1)	655	(95.0)	672	(97.5)
Std. Deviation		13.5	(1.96)	9.6	(1.40)			11.8	(1.72)	17.5	(2.54)		
TYS, MN/m^2 (ksi)	Avg	376	(54.6)	409	(59.3)	427	(61.9)	456	(66.2)	496	(71.9)	512	(74.2)
	Min	350	(50.8)	393	(57.0)	420	(60.9)	434	(62.9)	470	(68.1)	505	(73.2)
Std. Deviation		11.9	(1.73)	9.8	(1.43)			12.5	(1.82)	15.5	(2.25)		
Elong, percent	Avg	13.4		13.8		12.5		15.2		16.3		15.2	
	Min	9.7		12.5		12.0		11.0		12.0		15.0	
RA, percent	Avg	30.4		27.8				29.2		26.2		23	
	Min	24.0		26.5				28.0		25.5		22	
No. of Spec. (No. of Heats)		31	(12)	7	(4)	2	(1)	26	(11)	24	(10)	2	(1)
E, GN/m^2 (10^6 psi)	Avg	68.1	(9.88)					77.2	(11.2)	84.1	(12.2)		
	Min	63.4	(9.2)					71.0	(10.3)	72.4	(10.5)		
No. of Spec. (No. of Heats)		14	(3)					12	(3)	11	(3)		
Poisson's Ratio		0.33						0.33		0.37			
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg	463	(67.2)					558	(81.0)	583	(84.5)		
K_t = 10	Min	459	(66.6)					556	(80.7)				
No. of Spec. (No. of Heats)		2	(2)					2	(2)	2	(2)		
NTS, MN/m^2 (ksi)	Avg	567	(82.3)	571	(82.8)			631	(91.5)	707	(102.5)	690	(100)
K_t = 16	Min												
No. of Spec. (No. of Heats)													
Tension, Transverse													
TUS, MN/m^2 (ksi)	Avg	468	(67.9)	494	(71.7)			585	(84.8)	689	(99.9)		
	Min	460	(66.7)	491	(71.2)			565	(81.9)	638	(92.5)		
Std. Deviation		6.2	(0.90)					12.3	(1.78)	16.9	(2.45)		
TYS, MN/m^2 (ksi)	Avg	378	(54.9)	393	(57.0)			455	(66.0)	493	(71.5)		
	Min	365	(53.0)	378	(54.8)			441	(64.0)	458	(66.5)		
Std. Deviation			(1.21)					10.3	(1.49)	17.5	(2.54)		
Elong, percent	Avg	10.8		12.2				12.0		13.4			
	Min	7.5		11.1				9.3		9.8			
RA, percent	Avg	22.5		19.8				20.7		19.8			
	Min	13.0		16.7				14.0		12.0			
No. of Spec. (No. of Heats)		29	(12)	4	(2)			28	(12)	25	(10)		
E, GN/m^2 (10^6 psi)	Avg	70.3	(10.2)					78.6	(11.4)	88.2	(12.8)		
	Min	64.8	(9.4)					73.1	(10.6)	71.0	(10.3)		
No. of Spec. (No. of Heats)		16	(4)					15	(4)	13	(3)		
Poisson's Ratio		0.34						0.33		0.38			
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg	456	(66.2)					524	(76.0)	554	(80.3)		
K_t = 10	Min	449	(65.1)					520	(75.4)	547	(79.3)		
No. of Spec. (No. of Heats)		2	(2)					2	(2)	2	(2)		
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													

References: 62292, 64373, 64658, 66167, 72563, 84319, 90169, 90184

TABLE 4.2.2 – ME12

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920 A, ASTM B209
Form: Plate
Thickness, cm (in.): 1.27 to 2.54 (0.500 to 1.000)
Condition: T87

Testing Temperature, K (F)		297	(75)		77	(-320)	20	(-423)		
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear(a)										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., J(ft-lb)	Avg						8	(5.9)		
	Min						7.4	(5.5)		
No. of Spec. (No. of Heats)							6	(1)		
Trans., J(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness(b)										
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg									
	Min									
Orientation. –										
No. of Spec. (No. of Heats)										
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg	45.2	(41.4)		48.5	(44.4)				
(From PTSC spec.)(T – S)	Min	38.4	(35.1)		36.4	(33.3)				
No. of Spec. (No. of Heats)		8	(3)		7	(3)				

References: 5€ 50, 84319

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.2.2-ME12.1

Alloy Designation:	2219-T6E46
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T6E46 [Aged from T42 condition at 450 K (350 F), 12hr.]

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	452 (65.5)		531 (77.0)	638 (92.5)		
	Min	445 (64.6)		507 (73.6)	597 (86.6)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	314 (45.6)		369 (53.5)	419 (60.8)		
	Min	305 (44.2)		350 (50.8)	403 (58.4)		
Std. Deviation							
Elong, percent	Avg	15.2		18.0	18.8		
	Min	15.0		16.5	18.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg	79.3 (11.5)		80.0 (11.6)	--		
	Min	72.4 (10.5)		74.5 (10.8)	--		
No. of Spec. (No. of Heats)		3 (1)		2 (1)	--		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME12.2

Alloy Designation:	2219-T851
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T851

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	466 (67.6)	492 (71.4)	569 (82.5)	659 (95.6)	660 (95.7)	
	Min					657 (95.3)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	371 (53.8)	397 (57.6)	440 (63.8)	474 (68.8)	485 (70.3)	
	Min					476 (69.0)	
Std. Deviation							
Elong, percent	Avg	11.0	11.5	13.8	16.0	15.0	
	Min					14.0	
RA, percent	Avg	27	28	30	28	25.5	
	Min					25.0	
No. of Spec. (No. of Heats)		1	1	1	1	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	547 (79.4)	581 (84.3)	652 (94.5)	714 (103.5)	704 (102.1)	
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	458 (66.4)	490 (71.0)	572 (83.0)	667 (96.7)	660 (95.7)	
	Min					658 (95.5)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	353 (51.2)	379 (55.0)	421 (61.1)	465 (67.5)	481 (69.8)	
	Min					479 (69.5)	
Std. Deviation							
Elong, percent	Avg	10.2	10.5	12.2	15.8	13.0	
	Min					12.5	
RA, percent	Avg	22	22	24	25	20.5	
	Min					20.0	
No. of Spec. (No. of Heats)						2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	531 (77.0)	562 (81.5)	624 (90.5)	665 (96.5)	665 (96.5)	
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 72563

TABLE 4.2.2-ME12.3

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-TIG welded, 2319 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T6E46* Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	259 (37.5)	273 (39.6)		331 (48.0)	413 (59.9)	
	Min	239 (34.6)	249 (36.1)		274 (39.8)	386 (56.0)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	154 (22.4)	165 (24.0)		184 (26.7)	265 (38.4)	
	Min	147 (21.3)	157 (22.7)		171 (24.8)	249 (36.1)	
Std. Deviation							
Elong, percent	Avg	4.5	4.4		3.9	3.6	
	Min	3.0	3.0		2.0	3.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	4 (1)		4 (1)	4 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58761
* T42 + 450 K (350 F), 12 hr.

TABLE 4.2.2-ME12.4

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2310 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T62 Plate, welded and tested as heat treated to T62

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	395 (57.3)	416 (60.4)		475 (68.9)		496 (72.0)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	277 (40.2)	279 (40.5)		321 (46.6)		355 (51.5)
	Min						
Std. Deviation							
Elong, percent	Avg	7.5	6.5		5.5		3.5
	Min						
RA, percent	Avg	7	8		6		5
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	399 (57.9)	437 (63.4)		512 (74.2)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	287 (41.6)	311 (45.1)		352 (51.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	4.8	8.3		7.0		
	Min						
RA, percent	Avg	4	7		8		
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069, 90072

TABLE 4.2.2-ME12.5

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T81 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	278 (40.3)	285 (41.4)		372 (54.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	172 (25.0)	177 (25.6)		204 (29.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	5.2	5.2		4.0		
	Min						
RA, percent	Avg	3	3		2		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME12.6

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T81 Plate, tested as welded and aged to T81

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	330 (47.8)	357 (51.8)		450 (65.2)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	262 (38.0)	276 (40.0)		323 (46.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	3.0	3.0		4.8		
	Min						
RA, percent	Avg	2	2		--		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-12.7

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	196 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	282 (40.9)	285 (41.4)	310 (45.0)	393 (57.0)	427 (61.9)	
	Min	259 (37.5)	285 (41.3)	308 (44.7)	365 (53.0)	425 (61.6)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	170 (24.6)	172 (25.0)	196 (28.4)	204 (29.6)	268 (38.8)	
	Min	118 (17.1)	163 (23.6)	189 (27.4)	153 (22.2)	267 (38.7)	
Std. Deviation							
Elong, percent	Avg	5.2	4.5	5.3	7.6	4.0	
	Min	3.0	3.5	5.0	3.0	3.5	
RA, percent	Avg	25.7			18.3		
	Min	6 (2)	2 (1)	2 (1)	8 (2)	2 (1)	
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg		249 (36.1)		299 (43.3)		
K_t = 13.2	Min						
No. of Spec. (No. of Heats)			1		1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	279 (40.4)	287 (41.6)		390 (56.6)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	172 (25.0)	192 (27.8)		201 (29.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	5.2	6.2		3.5		
	Min						
RA, percent	Avg						
	Min				2		
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 76455, 90069, 90184

TABLE 4.2.2-ME12.8

Alloy Designation:	**2219 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Plate-MIG welded, 2319 Alloy filler**
Thickness, cm (in.):	**1.270 to 2.540 (0.500 to 1.000)**
Condition:	**T87 Plate, tested as welded and heat treated to T87**

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	324 (47.0)	341 (49.5)		425 (61.7)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	234 (34.0)	239 (34.6)		272 (39.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	3.5	3.0		3.2		
	Min						
RA, percent	Avg	2	2		2		
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME12.9

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-TIG welded, 2319 filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	276 (40.0)	283 (41.0)	301 (43.6)	409 (59.3)		
	Min	172 (25.0)	279 (40.5)	277 (40.2)	383 (55.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	163 (23.8)	171 (24.8)	181 (26.2)	192 (27.8)		
	Min	108 (15.8)	165 (24.0)	170 (24.6)	162 (23.5)		
Std. Deviation							
Elong, percent	Avg	6.5	4.5	4.9	9.5		
	Min	4.0	4.0	3.0	4.0		
RA, percent	Avg	25.6			22.1		
	Min	22.2			19.8		
No. of Spec. (No. of Heats)		8 (3)	2 (1)	4 (1)	9 (3)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	266 (38.6)		281 (40.7)	323 (46.8)		
K_t = 13.2	Min						
No. of Spec. (No. of Heats)		1		1	1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	276 (40)			386 (56)	462 (67)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	138 (20)			172 (25)	193 (28)	
	Min						
Std. Deviation							
Elong, percent	Avg	8			9	11	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 62292, 76455, 87195, 90184

TABLE 4.2.2-ME12.10

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, no filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	282 (40.9)			387 (56.2)	461 (66.8)	
	Min	249 (26.1)			274 (39.7)	432 (62.6)	
Std. Deviation					46.3 (6.72)		
TYS, MN/m^2 (ksi)	Avg	141 (20.4)			181 (26.3)	245 (35.5)	
	Min	102 (14.8)			148 (21.4)	213 (30.9)	
Std. Deviation					27.5 (3.99)		
Elong, percent	Avg	12.9			12.7	4.0	
	Min	5.0			6.5		
RA, percent	Avg	21.3			21.7	9	
	Min	12.9			13		
No. of Spec. (No. of Heats)		8 (3)			10 (3)	4 (2)	
E, GN/m^2 (10^6 psi)	Avg	66 (9.5)			76.5 (11.1)	67.6 (9.8)	
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)	2 (1)	
Poisson's Ratio		0.33			0.20	0.36	
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 76455, 84318, 89983

TABLE 4.2.2-ME13

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Plate
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: T87

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	469	(68.0)	536	(77.7)	573	(83.1)	596	(86.4)	695	(100.8)
	Min	448	(65.0)					573	(83.1)	680	(98.7)
Std Deviation		15.2	(2.20)					19.2	(2.79)	10.7	(1.56)
TYS, MN/m^2 (ksi)	Avg	383	(55.6)	433	(62.8)	475	(68.9)	469	(68.0)	510	(74.0)
	Min	361	(52.4)					441	(64.0)	496	(71.9)
Std Deviation		16.0	(2.32)					22.5	(3.26)	9.5	(1.38)
Elong, percent	Avg	11.2		14		13		14		13.4	
	Min	10						10.5		7.5	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		10	(4)	3	(1)	3	(1)	10	(4)	10	(4)
E, GN/m^2 (10^6 psi)	Avg	67.7	(9.82)					75.2	(10.9)	77.2	(11.2)
	Min	65.5	(9.50)					73.1	(10.6)	73.7	(10.7)
No. of Spec. (No. of Heats)		5	(1)					5	(1)	3	(1)
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	480	(69.6)					561	(81.4)	601	(87.2)
K_t = 10	Min	478	(69.4)					548	(79.5)	598	(86.7)
No. of Spec. (No. of Heats)		2	(1)					2	(1)	2	(1)
NTS, MN/m^2 (ksi)	Avg	363	(52.6)	405	(58.7)	396	(57.4)	449	(65.1)	455	(66.0)
K_t = 21.6	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	467	(67.8)	518	(75.2)	540	(78.4)	585	(84.9)	683	(99.0)
	Min	444	(64.4)					547	(79.4)	659	(95.6)
Std Deviation		14.9	(2.16)					20.9	(3.04)	17.4	(2.53)
TYS, MN/m^2 (ksi)	Avg	381	(55.2)	424	(61.5)	444	(64.4)	459	(66.6)	498	(72.2)
	Min	353	(51.2)					433	(62.8)	478	(69.4)
Std Deviation		18.5	(2.69)					21.7	(3.15)	18.5	(2.68)
Elong, percent	Avg	9.4		8.5		9		10.6		10.6	
	Min	8.0						7.0		6.3	
RA, percent	Avg	16						18		22	
	Min									19	
No. of Spec. (No. of Heats)		13	(5)	3	(1)	3	(1)	13	(6)	14	(6)
E, GN/m^2 (10^6 psi)	Avg	70.3	(10.2)					75.8	(11.0)	78.6	(11.4)
	Min	69.5	(10.1)					72.4	(10.5)	75.2	(10.9)
No. of Spec. (No. of Heats)		4	(1)					5	(1)	5	(1)
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	448	(65.0)					536	(77.8)	545	(79.1)
K_t = 10	Min	414	(60.1)					494	(71.7)	514	(74.6)
No. of Spec. (No. of Heats)		2	(1)					2	(1)	2	(1)
NTS, MN/m^2 (ksi)	Avg	350	(50.8)	364	(52.8)	356	(51.7)	396	(57.5)	378	(54.8)
K_t = 21.6	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)

References: 64658, 84319, 90180

TABLE 4.2.2-ME21.2

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-EB welded, 2319 Alloy filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	236 (34.2)			361 (52.3)		
	Min	132 (19.2)			254 (36.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	132 (19.1)			172 (24.9)		
	Min	116 (16.8)			145 (21.0)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (1)			6 (1)		
E, GN/m^2 (10^6 psi)	Avg	74.5 (10.8)			84.1 (12.2)		
	Min	63.4 (9.2)			77.9 (11.3)		
No. of Spec. (No. of Heats)		6 (1)			4 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.3

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-EB welded, 2319 Alloy filler
Thickness, cm (in.): Over 5.080 (2.000)
Condition: T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	288 (41.8)			416 (60.2)		
	Min	161 (23.4)			349 (50.6)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	187 (27.1)			254 (36.9)		
	Min	163 (23.6)			242 (35.1)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (1)			5 (1)		
E, GN/m² (10⁶ psi)	Avg	74.5 (10.8)			81.3 (11.8)		
	Min	73.1 (10.6)			80.0 (11.6)		
No. of Spec. (No. of Heats)		4 (1)			3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME14

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Plate
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: T87

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Short Transverse							
TUS, MN/m^2 (ksi)	Avg	441 (64)		523 (75.9)	544 (78.9)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	374 (54.3)		524 (76.0)	532 (77.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	4.3		2.7	1.3		
	Min	(1)		(1)	(1)		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64658

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TABLE 4.2.2-ME15

Alloy Designation: 2219-T87 Aluminum Alloy

Specification:	MIL-A-8920A, ASTM B209
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	T87

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg	40.3 (36.9)		45.5 (41.6)	48.2 (44.3)		
(From PTSC spec.)(T – S)	Min	39.2 (35.9)		44.3 (40.5)	46.9 (42.9)		
No. of Spec. (No. of Heats)		6 (4)		6 (3)	5 (2)		

References: 84319, 84320

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 5.2.2-ME15.1

Alloy Designation: 2219-T6E46

Specification:
Form: Plate
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: T6E46 [Aged from T42 condition of 450 K (350 F), 12 hr.]

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	442 (64.1)		541 (78.5)	671 (97.3)		
	Min	437 (63.4)		530 (76.7)	665 (96.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	301 (43.7)		352 (51.1)	403 (58.4)		
	Min	296 (43.0)		340 (49.3)	388 (56.3)		
Std. Deviation							
Elong, percent	Avg	17.3		20.3	16.7		
	Min	16.0		19.0	15.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME15.2

Alloy Designation:	2219-T62						
Specification:							
Form:	Plate						
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)						
Condition:	T62						

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	423 (61.3)		523 (75.9)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	292 (42.3)		330 (47.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	12.0		14.0			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1		1			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	494 (71.6)		603 (87.5)			
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1		1			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90084

TABLE 4.2.2-ME15.3

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	T851 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	225 (32.7)	281 (40.8)		356 (51.7)		411 (59.6)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	185 (26.8)	172 (25.0)		193 (28.0)		277 (40.2)
	Min						
Std. Deviation							
Elong, percent	Avg	2.0	4.0		3.5		2.5
	Min						
RA, percent	Avg	5	15		10		10
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

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TABLE 4.2.2-ME16

Alloy Designation:	2219-T81 Aluminum Alloy
Specification:	MIL-A-8920A, ASTM B209
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T81

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	445 (64.5)		576 (83.5)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	348 (50.5)		436 (63.3)			
	Min						
Std. Deviation							
Elong, percent	Avg	9		10			
	Min						
RA percent	Avg	16		17			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	440 (63.9)		511 (74.1)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	337 (48.9)		399 (57.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	6		3			
	Min						
RA, percent	Avg	9		7			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

TABLE 4.2.2-ME17

Alloy Designation: 2219-T81 Aluminum Alloy

Specification:	MIL-A-8920A, ASTM B209
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T81

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Short Transverse							
TUS, MN/m^2 (ksi)	Avg	402 (58.3)		487 (70.6)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	335 (48.6)		382 (55.4)			
	Min						
Std. Deviation							
Elong, percent	Avg			3			
	Min						
RA, percent	Avg	8		3			
	Min						
No. of Spec. (No. of Heats)		(1)		(1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

TABLE 4.2.2-ME18

Alloy Designation:	2219-T87 Aluminum Alloy
Specification:	MIL-A-8920A, ASTM B209
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	472 (68.5)		591 (85.7)	676 (98.1)		
	Min	455 (66.0)		560 (81.2)	576 (83.6)		
Std. Deviation		11.9 (1.72)		21.1 (3.06)	47.9 (6.95)		
TYS, MN/m^2 (ksi)	Avg	383 (55.6)		465 (67.5)	512 (74.3)		
	Min	368 (53.4)		428 (62.1)	490 (71.0)		
Std. Deviation		10.8 (1.56)		23.8 (3.45)	28.8 (4.18)		
Elong, percent	Avg	9.7		10.9	10.4		
	Min	6.3		5.8	4.7		
RA, percent	Avg	19		23.1	15.9		
	Min	15.1		19	13.4		
No. of Spec. (No. of Heats)		11 (3)		10 (3)	10 (3)		
E, GN/m^2 (10^6 psi)	Avg	73.8 (10.7)		92.4 (13.4)	80.0 (11.6)		
	Min	70.3 (10.2)		73.8 (10.7)	73.1 (10.6)		
No. of Spec. (No. of Heats)		4 (1)		3 (1)	2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	461 (66.8)		547 (79.3)	586 (85.0)		
K_t = 10	Min	441 (63.9)		517 (75.0)	556 (80.6)		
No. of Spec. (No. of Heats)		5 (1)		5 (1)	5 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	470 (68.1)		585 (84.8)	664 (96.3)		
	Min	443 (64.3)		554 (80.4)	595 (86.3)		
Std. Deviation		11.1 (1.61)		15.9 (2.31)	39.7 (5.76)		
TYS, MN/m^2 (ksi)	Avg	382 (55.4)		451 (65.4)	491 (71.2)		
	Min	370 (53.7)		427 (61.9)	474 (68.8)		
Std. Deviation		7.0 (1.02)		15.7 (2.27)	20.2 (2.93)		
Elong, percent	Avg	8.3		9.1	8.6		
	Min	5.0		4.7	4.8		
RA, percent	Avg	13.2		15.9	12.5		
	Min	9.6		9	11.1		
No. of Spec. (No. of Heats)		10 (3)		11 (3)	10 (3)		
E, GN/m^2 (10^6 psi)	Avg	75.8 (11.0)		83.4 (12.1)	70.3 (10.2)		
	Min	73.8 (10.7)		67.6 (9.8)	64.8 (9.4)		
No. of Spec. (No. of Heats)		3 (1)		4 (1)	3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	384 (55.7)		435 (63.1)	452 (65.5)		
K_t = 10	Min	356 (51.7)		404 (58.6)	438 (63.6)		
No. of Spec. (No. of Heats)		5 (1)		5 (1)	5 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64658, 84319, 93338

TABLE 4.2.2-ME19

Alloy Designation: 2219-T87 Aluminum Alloy

Specification:	MIL-A-8920A, ASTM B209
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Short Transverse							
TUS, MN/m^2 (ksi)	Avg	472 (68.5)		533 (77.3)	545 (79.1)		
	Min	445 (64.6)		459 (66.6)	449 (65.1)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	376 (54.5)		452 (65.5)	483 (70.0)		
	Min	375 (54.4)		413 (59.9)	480 (69.6)		
Std. Deviation							
Elong, percent	Avg	7.8					
	Min	7.0					
RA, percent	Avg	7.4		5.5			
	Min	6.7					
No. of Spec. (No. of Heats)		4 (2)		3 (2)	3 (2)		
E, GN/m^2 (10^6 psi)	Avg	72.4 (10.5)		64.1 (9.3)			
	Min	70.3 (10.2)		55.2 (8.0)			
No. of Spec. (No. of Heats)		4 (1)		2 (1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	283 (41.1)		322 (46.7)	362 (52.5)		
K_t = 10	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64658 , 93338

TABLE 4.2.2-ME20

Alloy Designation: 2219-T87 Aluminum Alloy

Results of Boeing program to determine design allowable properties

Form: Sheet and Plate

Thickness, cm (in.): 0.081 to 10.2 (0.032 to 4.00)

Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m^2 (ksi) Avg	474 (68.7)		578 (83.8)	685 (99.3)		
99% P, 95% C, F_{tu}[a]	443 (64.3)		537 (77.9)	625 (90.5)		
TYS, MN/m^2 (ksi) Avg	391 (56.7)		454 (65.9)	498 (72.2)		
99% P, 95% C, F_{ty}[a]	354 (51.4)		410 (59.4)	454 (65.8)		
Elong, percent Avg						
Min						
RA, percent Avg						
Min						
No. of Spec. (No. of Heats)						
E, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m^2 (ksi) Avg						
K_t = Min						
No. of Spec. (No. of Heats)						
NTS, MN/m^2 (ksi) Avg						
K_t = Min						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m^2 (ksi) Avg	476 (69.0)		585 (84.8)	692 (100.4)		
99% P, 95% C, F_{tu}[a]	445 (64.6)		543 (78.7)	649 (94.1)		
TYS, MN/m^2 (ksi) Avg	388 (56.2)		454 (65.9)	495 (71.8)		
99% P, 95% C, F_{ty}[a]	350 (50.7)		412 (59.8)	446 (64.7)		
Elong, percent Avg						
Min						
RA, percent Avg						
Min						
No. of Spec. (No. of Heats)						
E, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m^2 (ksi) Avg						
K_t = Min						
No. of Spec. (No. of Heats)						
NTS, MN/m^2 (ksi) Avg						
K_t = Min						
No. of Spec. (No. of Heats)						

References: 84319

(a) "A" values corresponding to 99 percent probability, 95 percent confidence level.

TABLE 4.2.2-ME21

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: T87

Testing Temperature, K (F)		297	(75)		77	(-320)	20	(-423)		
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear[a]										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Trans., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness[b]										
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg	39.7	(36.3)		46.3	(42.4)	52.5	(48.0)		
Bend Specimens	Min	39.6	(36.2)		45.5	(41.6)	51.6	(47.2)		
Orientation: T – S										
No. of Spec. (No. of Heats)		2	(1)		2	(1)	2	(1)		
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg	28.6	(26.2)		34.3	(31.4)	37.2	(34.0)		
Compact Specimens	Min	28.5	(26.1)		34.2	(31.3)	36.1	(33.0)		
Orientation: T – S										
No. of Spec. (No. of Heats)		2	(1)		2	(1)	2	(1)		
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg	49.5	(45.3)		52.7	(48.2)				
(From PTSC spec.)(T – S)	Min	43.0	(39.3)		43.6	(39.9)				
No. of Spec. (No. of Heats)		5	(2)		6	(2)				
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg	53.3	(48.7)		52.7	(55.3)				
(From PTSC spec.)(–)	Min	50.3	(46)		59.1	(54)				
No. of Spec. (No. of Heats)		3	(1)		6	(2)				

References: 84319, 93338

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.2.2-ME21.1

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.):	over 5.080 (2.000)
Condition:	T81 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	268 (38.9)			315 (45.7)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	140 (20.3)			164 (23.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	8			7		
	Min						
RA, percent	Avg	15			9		
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

TABLE 4.2.2-ME21.4

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)				77 (-320)			
Tension, Longitudinal									
TUS, MN/m^2 (ksi)	Avg	236	(34.2)			261	(37.9)		
	Min	196	(28.4)			219	(31.7)		
Std. Deviation									
TYS, MN/m^2 (ksi)	Avg	139	(20.1)			171	(24.8)		
	Min	115	(16.7)			152	(22.0)		
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		8	(1)			5	(1)		
E, GN/m^2 (10^6 psi)	Avg	71.0	(10.3)			80.7	(11.7)		
	Min	66.2	(9.6)			78.6	(11.4)		
No. of Spec. (No. of Heats)		8	(1)			5	(1)		
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m^2 (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m^2 (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									

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References: 88109

TABLE 4.2.2-ME21.5

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87 plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	276 (40.1)			305 (44.2)		
	Min	243 (35.2)			213 (30.9)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	166 (24.1)			226 (32.8)		
	Min	141 (20.4)			186 (27.0)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			5 (1)		
E, GN/m^2 (10^6 psi)	Avg	66 (9.5)			80.0 (11.6)		
	Min	58 (8.4)			77.9 (11.3)		
No. of Spec. (No. of Heats)		4 (1)			5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.6

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 2319 Alloy filler
Thickness, cm (in.): Over 5.080 (2.000)
Condition: T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi√in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi√in.)	Avg	33.7 (30.9)			33.7 (30.9)		
(From PTSC spec.)(—)	Min	30.1 (27.6)			30.7 (28.1)		
No. of Spec. (No. of Heats)		5 (1)			4 (1)		

References: 88109

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.2.2-ME21.7

Alloy Designation:	**2219 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Plate-Pulse TIG welded, 2319 Alloy filler**
Thickness, cm (in.):	**Over 5.080 (2.000)**
Condition:	**T87 Plate, tested as welded**

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	290 (42.0)			375 (54.4)		
	Min	263 (38.2)			320 (46.4)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	145 (21.0)			189 (27.4)		
	Min	124 (18.0)			161 (23.3)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg	73.1 (10.6)			84.8 (12.3)		
	Min	71.0 (10.3)			82.1 (11.9)		
No. of Spec. (No. of Heats)		8 (1)			4 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-21.8

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, 2319 Alloy filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	308 (44.7)			337 (48.9)		
	Min	305 (44.2)			231 (33.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	192 (27.8)			224 (32.5)		
	Min	178 (25.8)			197 (28.5)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg	77.2 (11.2)			88.3 (12.8)		
	Min	73.1 (10.6)			78.6 (11.4)		
No. of Spec. (No. of Heats)		4 (1)			3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.9

Alloy Designation:	2219 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-Pulse TIG welded, 2319 Alloy filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)				77 (-320)			
Compression, Longitudinal									
CYS, MN/m^2 (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Ec, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Compression, Transverse									
CYS, MN/m^2 (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Ec, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Shear[a]									
SUS, MN/m^2 (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
G, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Impact, Charpy V									
Long., Nm(ft-lb)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Trans., Nm(ft-lb)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Fracture Toughness[b]									
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg								
	Min								
Orientation: —									
No. of Spec. (No. of Heats)									
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg	44.0	(40.3)			41.5	(38.0)		
(From PTSC spec.)(—)	Min	39.7	(36.4)			40.7	(37.3)		
No. of Spec. (No. of Heats)		3	(1)			3	(1)		

References: 88109

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

150

TABLE 4.2.2-ME22

Alloy Designation:	2219-T852 Aluminum Alloy
Specification:	QQ-A-367F
Form:	Forgings
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T852

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Radial							
TUS, MN/m^2 (ksi)	Avg	446 (64.7)		543 (78.8)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	333 (48.3)		395 (57.4)			
	Min						
Std. Deviation							
Elong, percent	Avg	13		15			
	Min						
RA, percent	Avg	25		36			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Tangential							
TUS, MN/m^2 (ksi)	Avg	448 (65.0)		540 (78.4)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	345 (50.1)		399 (57.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	10		14			
	Min						
RA, percent	Avg	17		25			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

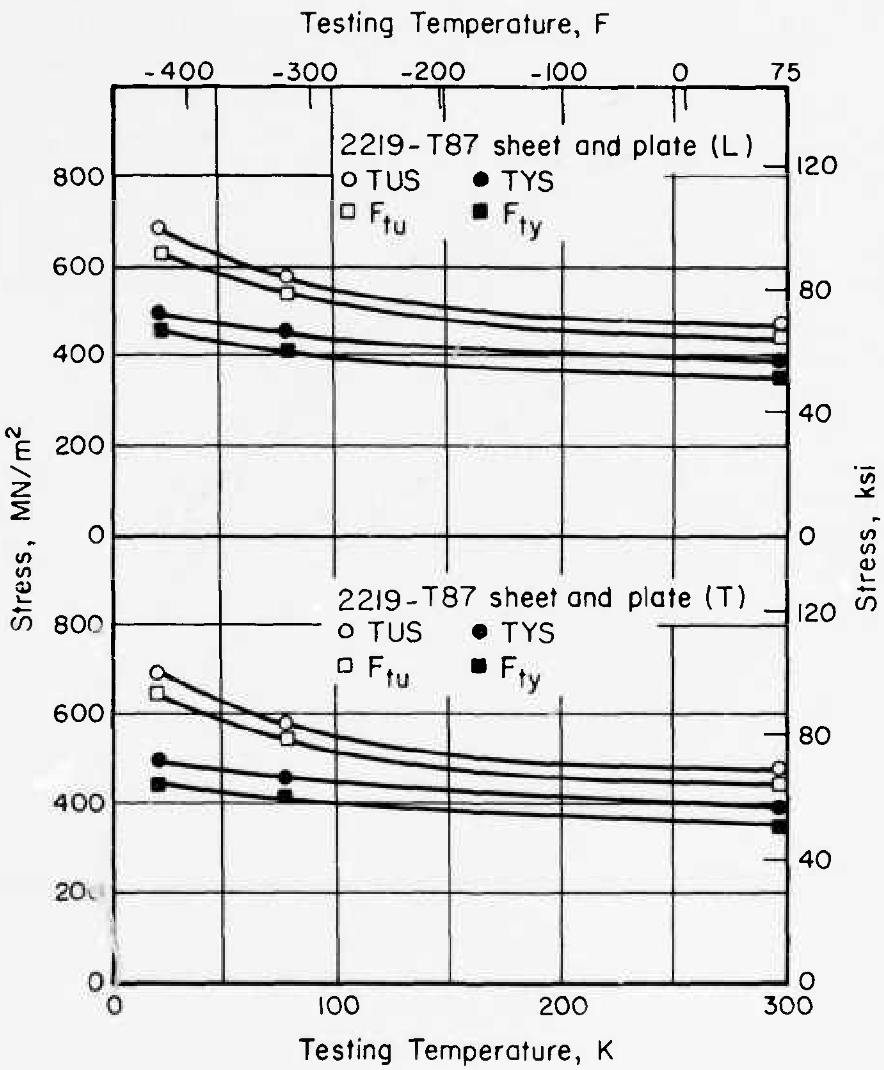

FIGURE 4.2.2-ME3. EFFECT OF TEMPERATURE ON THE STRENGTH OF 2219-T87 SHEET AND PLATE FROM BOEING PROGRAM TO DETERMINE DESIGN ALLOWABLE PROPERTIES (84319)

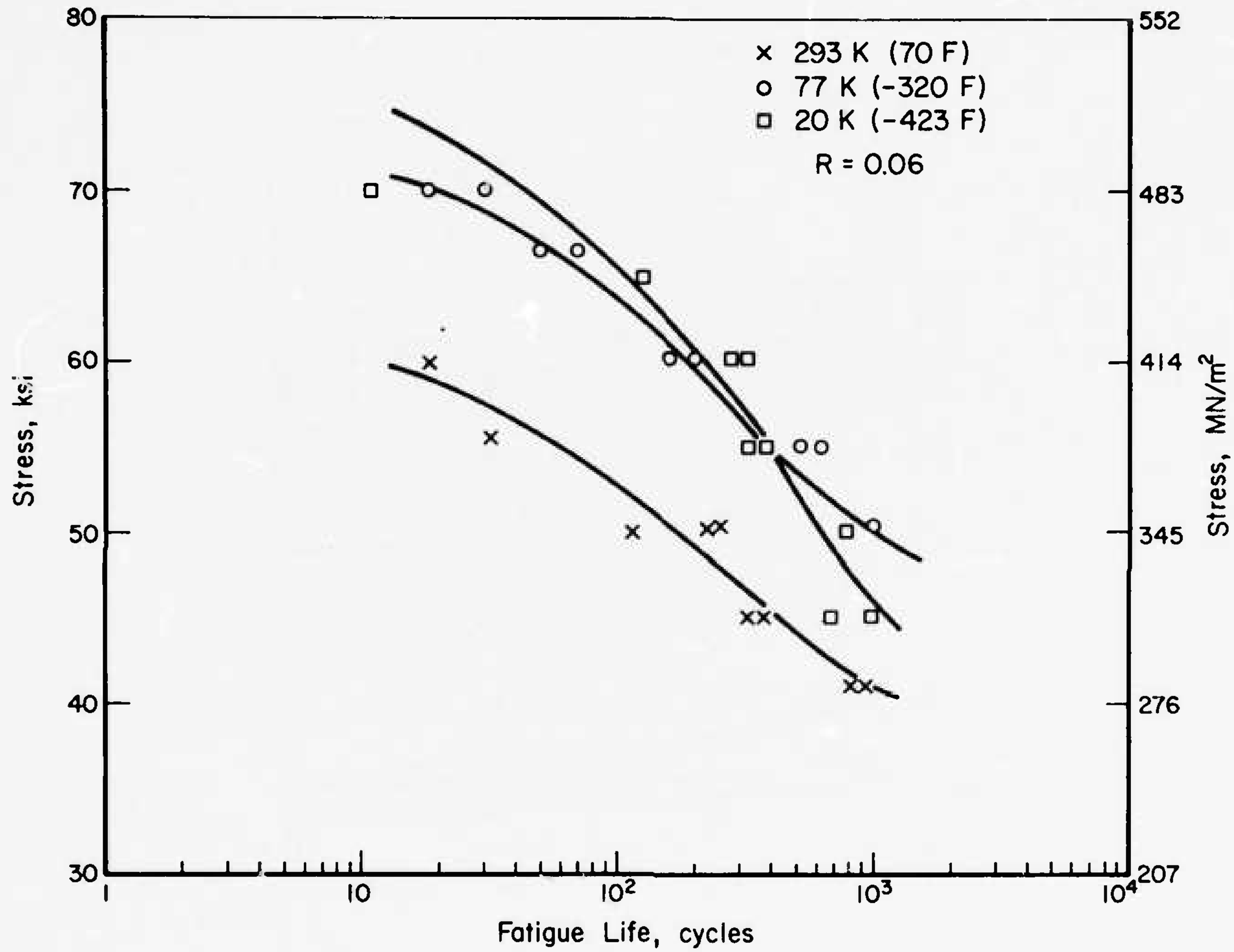

FIGURE 4.2.2-ME4. FATIGUE LIFE CURVES FOR AXIAL LOADING ON NOTCHED SPECIMENS FROM ALUMINUM 2219-T6E46 PLATE 1.9 cm (1.25 in.) THICK [58761]

4.2.2-27.1 (11/76)

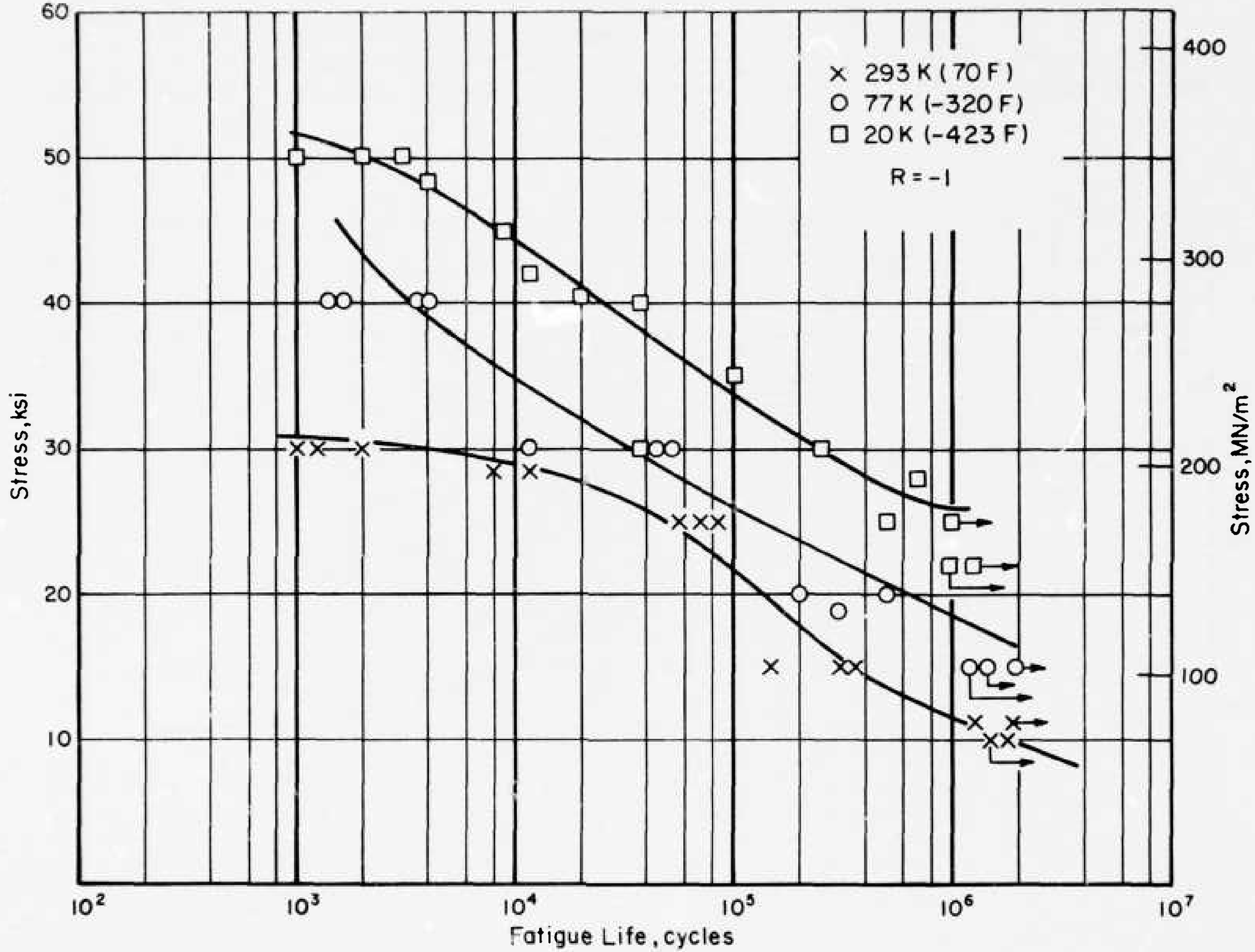

FIGURE 4.2.2-ME4.1. AXIAL FATIGUE LIFE CURVES FOR LOADING ON WELD METAL SPECIMENS FROM TIG WELDED 2219-T62 ALUMINUM ALLOY 0.100 to 0.319 cm (0.040 to 0.125 in.) THICK SHEET AT R = -1 (2319 ALLOY FILLER) [Transverse weld orientation] [61996]

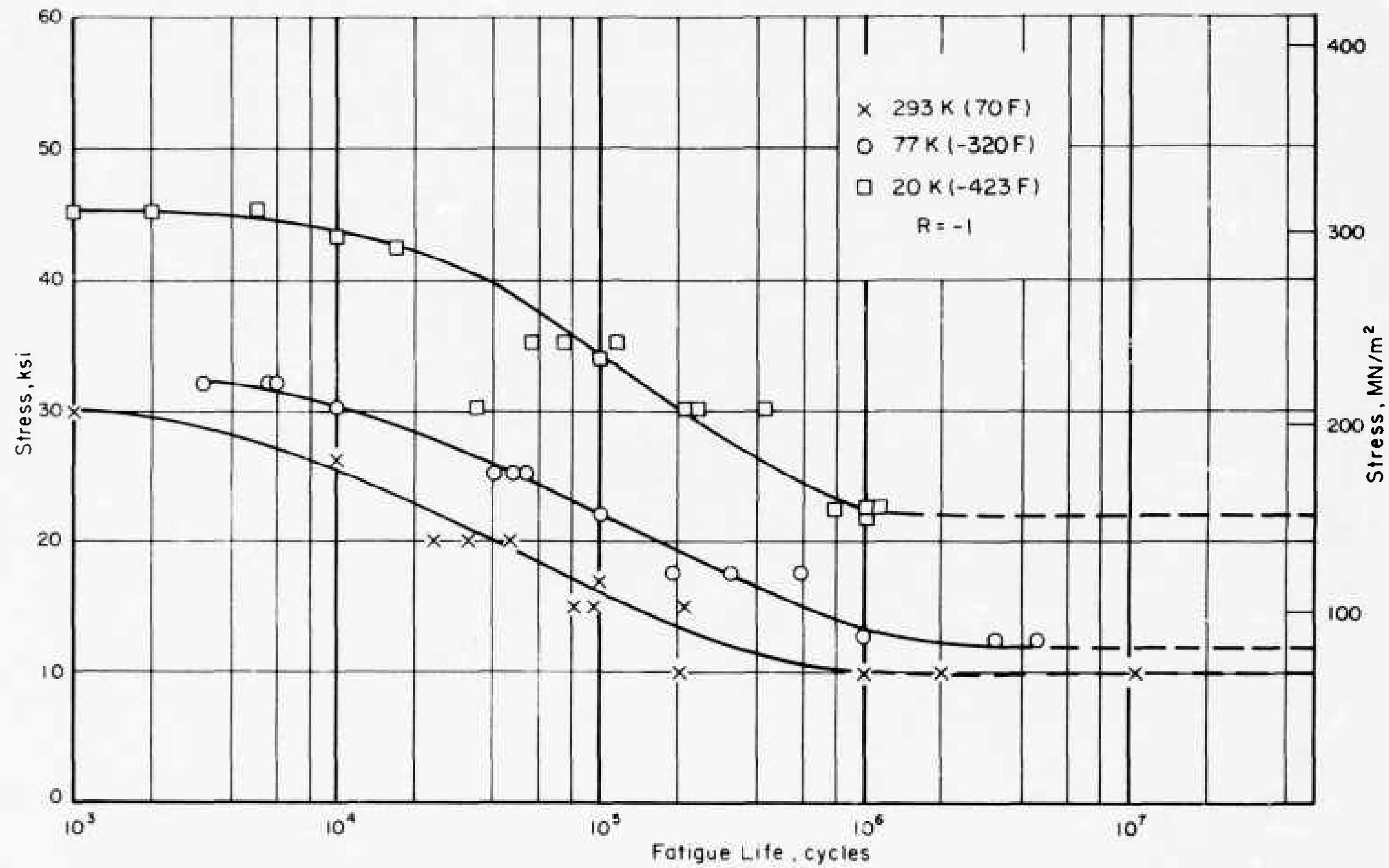

FIGURE 4.2.2-ME5. FATIGUE LIFE CURVES FOR AXIAL LOADING ON WELD METAL SPECIMENS FROM TIG WELDED 2219-T87 ALUMINUM ALLOY 0.254 cm (0.100 in.) THICK SHEET AT R = -1(2319 ALLOY FILLER) [Transverse weld orientation] [53308]

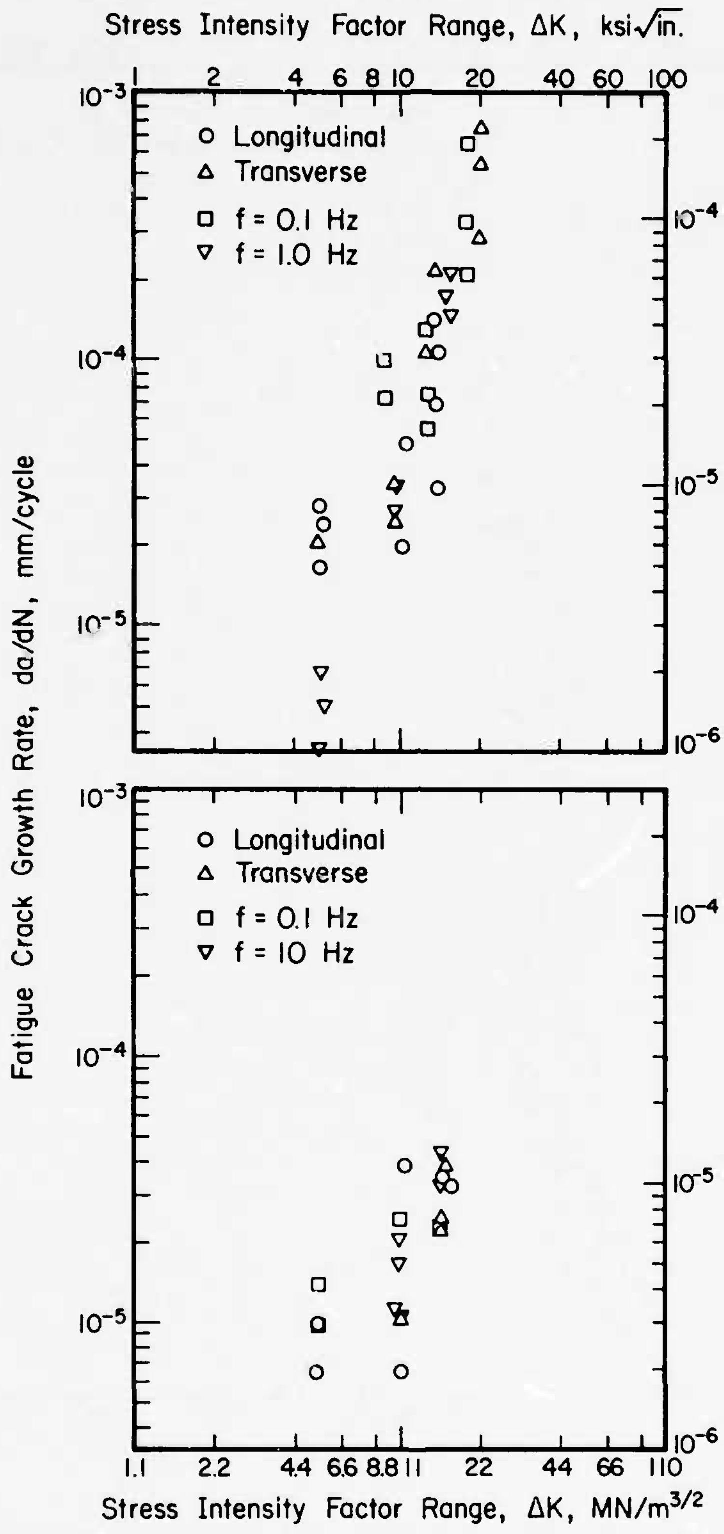

FIGURE 4.2.2-ME6. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE [Crack oriented to propagate in plane of longitudinal rolling direction and long transverse direction] [93338]

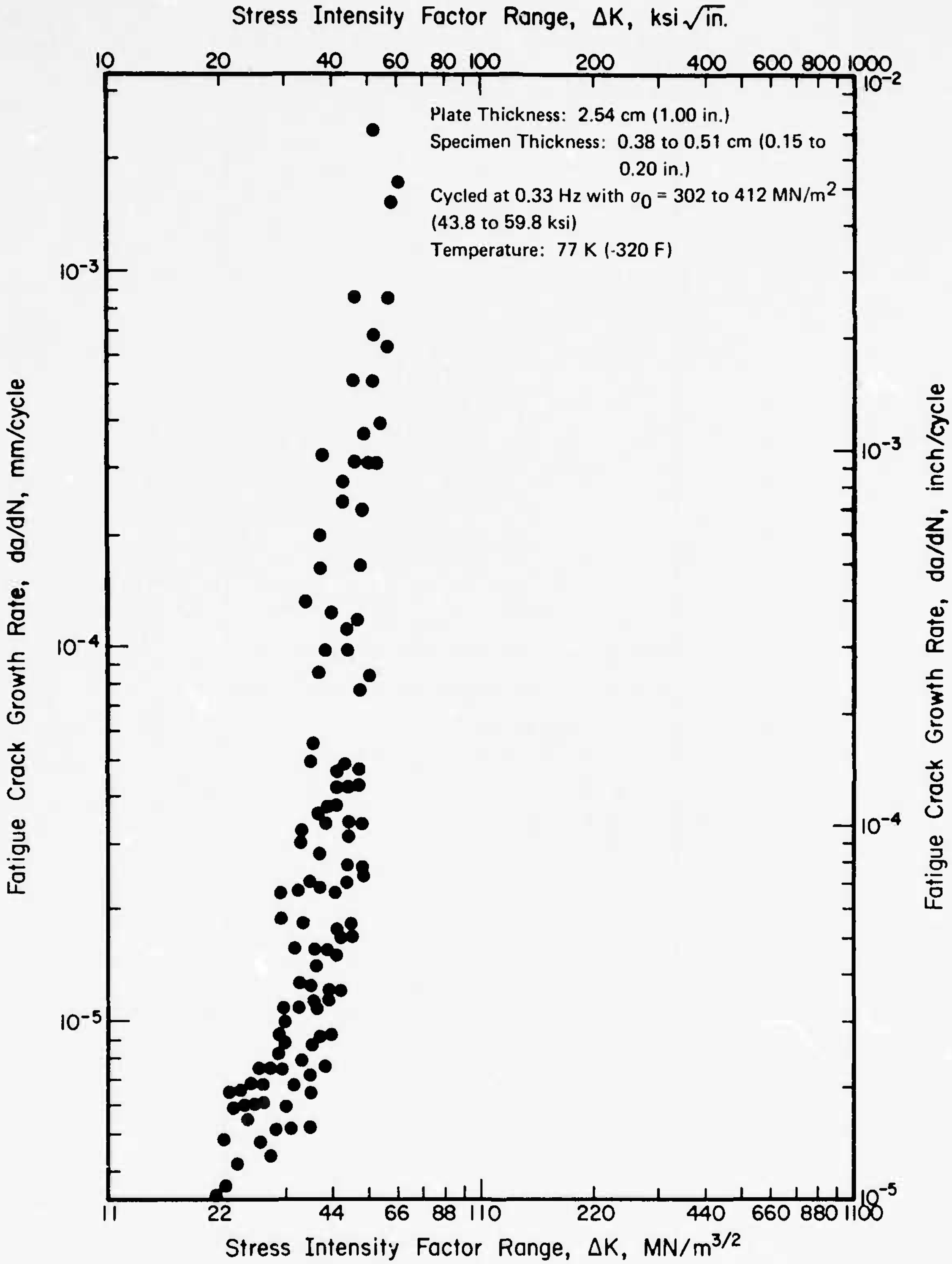

FIGURE 4.2.2-ME7. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE [Crack orientation T-S: crack plane parallel to rolling direction; propagation through the plate thickness] [89716]

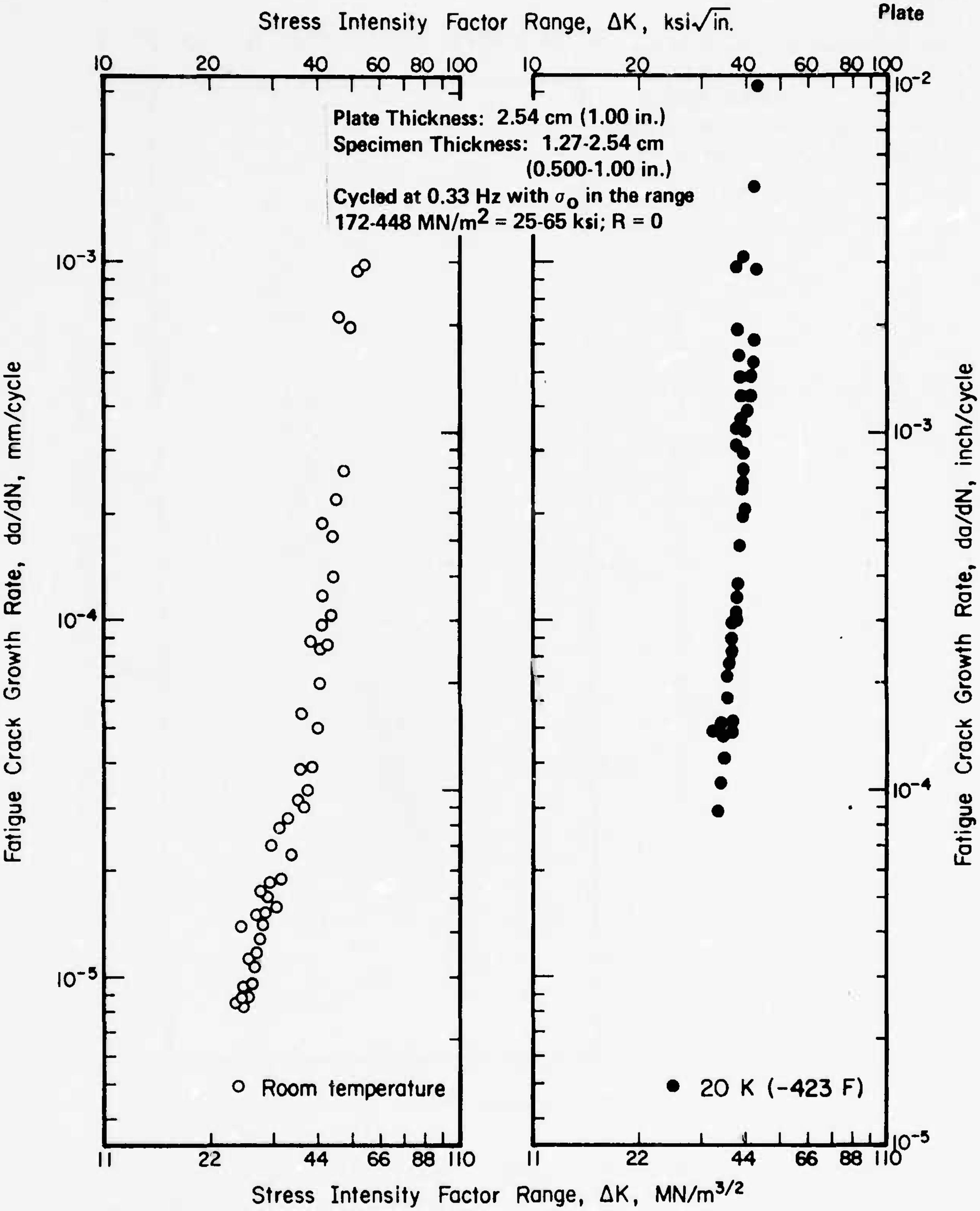

FIGURE 4.2.2-ME8. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE AT ROOM TEMPERATURE AND -20 K (-423 F) [Crack orientation T-S: crack plane parallel to rolling direction, propagation through the plate thickness] [86296]

Plate Thickness: 2.54 cm (1.00 in.)
Specimen Thickness: 1.27-2.54 cm (0.50-1.00 in.)
Cycled at 0.33 Hz with σ_o in the range 172-448 MN/m^2 = 25-65 ksi; R = 0

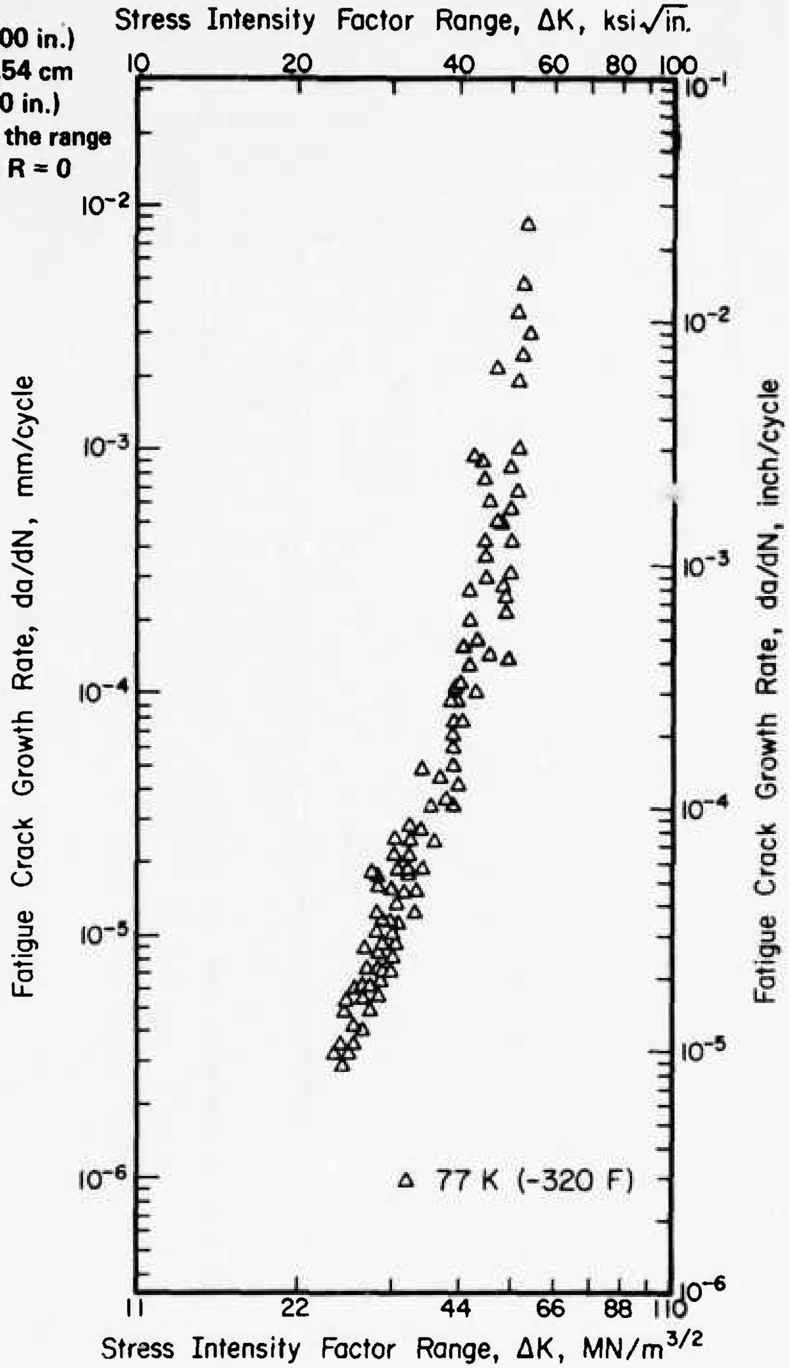

FIGURE 4.2.2-ME9. FATIGUE CRACK GROWHT RATE OF 2219-T87 ALUMINUM ALLOY PLATE AT 77 K (-320 F) [Crack orientation T-S: crack plane parallel to rolling direction, propagation through the plate thickness] [89716]

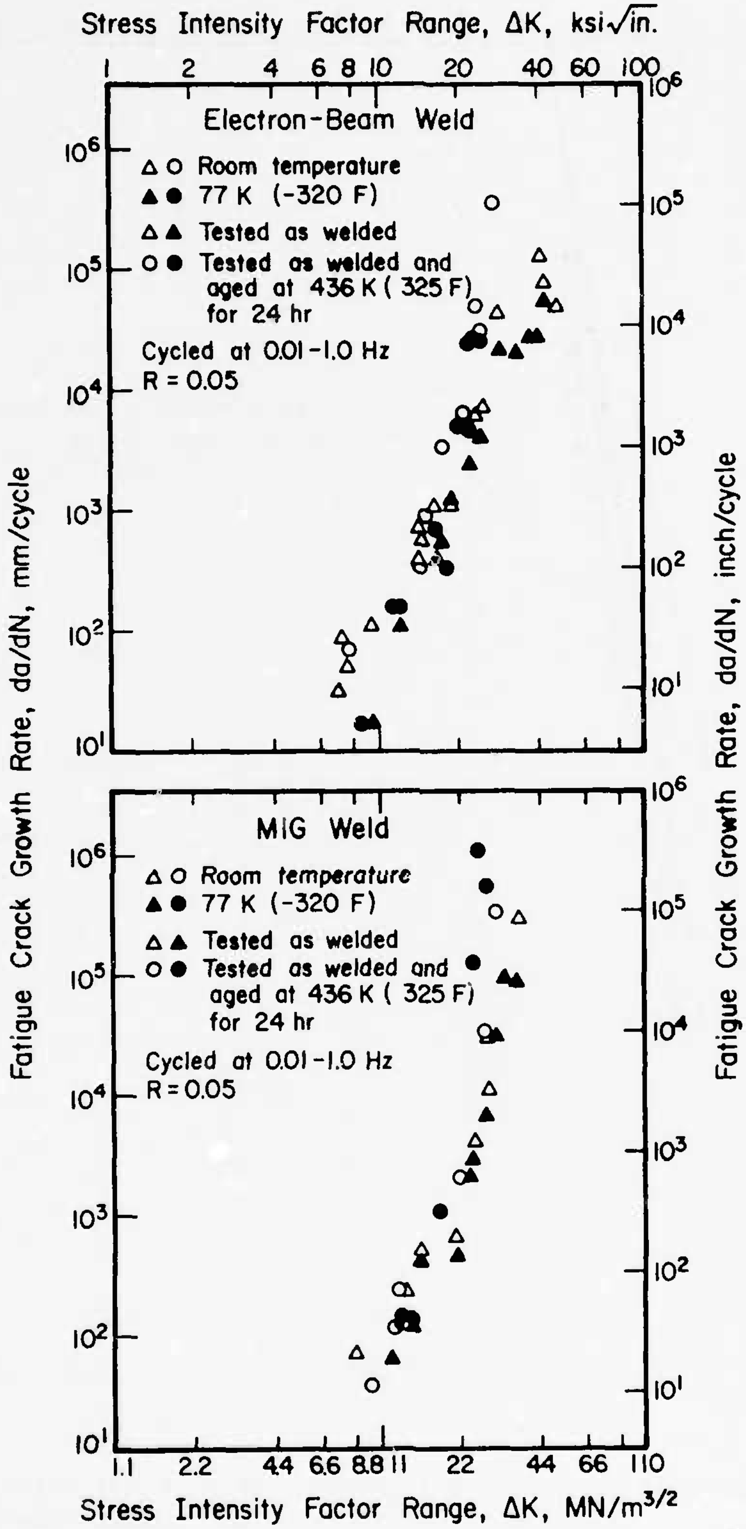

FIGURE 4.2.2-ME10. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE EB AND MIG WELDED (2319 ALLOY FILLER) [Transverse weld orientation] [88109]
Plate thickness=8.25 cm (3.25 in.);Specimen thickness=5.08 cm (2.00 in.)

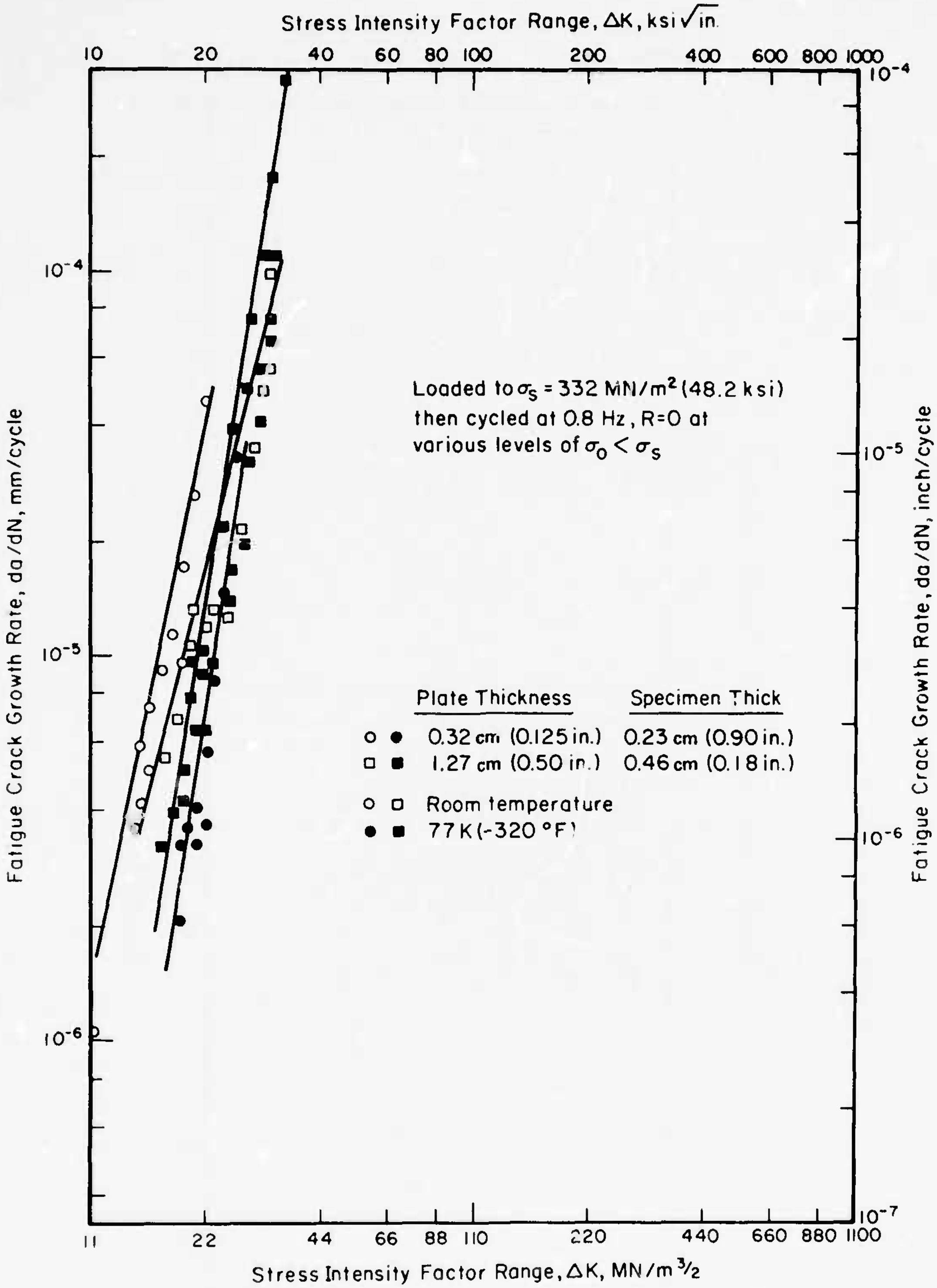

FIGURE 4.2.2-ME11. FATIGUE CRACK GROWTH RATE OF 2219-T62 ALUMINUM ALLOY [Crack orientation L-S: crack plane transverse to rolling direction, propagation through the plate thickness] [87612]

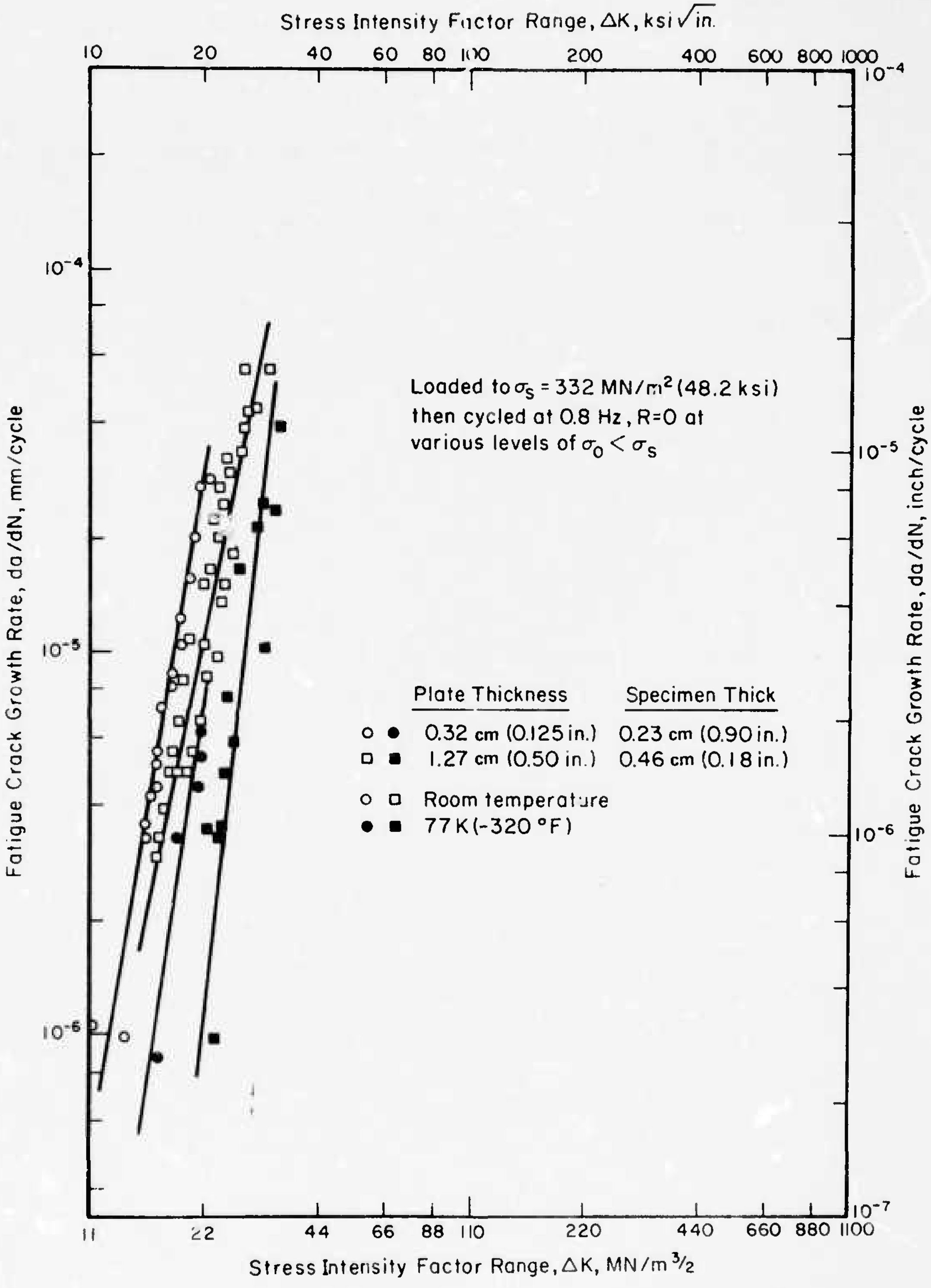

FIGURE 4.2.2-ME12. FATIGUE CRACK GROWTH RATE OF 2219 ALUMINUM ALLOY PLATE MIG WELDED (2319 ALLOY FILLER), HEAT TREATED TO T62, AND TESTED [Transverse weld orientation] [87612]

TABLE 4.2.2-TR1

Alloy Designation: 2219-T81 Aluminum Alloy

Specification:
Form:
Dimension:
Condition: -T81

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	118		68		45.5		26.3					
Btu hr^{-1} ft^{-1} F^{-1}		(68.2)		(39.3)		(26.3)		(15.2)				
No. of Spec.	1		1		1		1					
References: 90218												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.313		-0.346		-0.350					
No. of Spec.	1		1		1		1					
References: 48571												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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TABLE 4.2.3-ME1

Alloy Designation:	2024-T3 Aluminum Alloy
Specification:	QQ-A-355
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	T3

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	468 (67.9)	484 (70.2)		600 (87.0)	758 (110)	
	Min	467 (67.8)	482 (69.9)		594 (86.1)	752 (109)	
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	327 (47.4)	337 (48.9)		420 (60.9)	504 (73.1)	
	Min	324 (47.0)	332 (48.1)		415 (60.2)	489 (70.9)	
Std Deviation							
Elong, percent	Avg	18	21		22	17	
	Min	18	20		22	14	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg	70.3 (10.2)	72.4 (10.5)		75.2 (10.9)	78.6 (11.4)	
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	415 (60.2)	422 (61.2)		525 (76.2)	612 (88.8)	
K_t = 6.3	Min	412 (59.8)	414 (60.0)		520 (75.4)	585 (84.8)	
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	4 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	454 (65.8)	467 (67.8)		575 (83.4)	738 (107)	
	Min	451 (65.4)	467 (67.7)		574 (83.2)	731 (106)	
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	303 (43.9)	307 (44.5)		387 (56.1)	476 (69.0)	
	Min	302 (43.8)	303 (44.0)		384 (55.7)	475 (68.9)	
Std Deviation							
Elong, percent	Avg	18	21		22	18	
	Min	18	21		22	17	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg	71.0 (10.3)	73.1 (10.6)		75.8 (11.0)	79.3 (11.5)	
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	434 (62.9)	433 (62.8)		515 (74.7)	598 (86.8)	
K_t = 6.3	Min	432 (62.6)	432 (62.7)		510 (73.9)	589 (85.4)	
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90073, 90078

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TABLE 4.2.3-ME2

Alloy Designation:	2024-T4 Aluminum Alloy
Specification:	QQ-A-355
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	T4

Testing Temperature, K (F)		297	(75)	195	(-108)		77	(-320)	20	(-423)	
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	467	(67.7)	481	(69.8)		585	(84.9)	738	(107)	
	Min	461	(66.9)	480	(69.6)		578	(83.9)	710	(103)	
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	295	(42.8)	301	(43.7)		373	(54.1)	505	(73.3)	
	Min	294	(42.6)	296	(43.0)		361	(52.4)	489	(70.9)	
Std. Deviation											
Elong, percent	Avg	19		22			27		16		
	Min	19		20			24		12		
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)		3	(1)	3	(1)	
. GN/m^2 (10^6 psi)	Avg	73.8	(10.7)	73.7	(10.7)		77.2	(11.2)	80.0	(11.6)	
	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)		3	(1)	3	(1)	
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	407	(59.0)	419	(60.7)		496	(71.9)	609	(88.3)	
K_t = 6.3	Min	402	(58.3)	414	(60.1)		491	(71.2)	588	(85.3)	
No. of Spec. (No. of Heats)		3	(1)	3	(1)		3	(1)	3	(1)	
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	463	(67.1)	469	(68.0)		564	(81.8)	669	(97.1)	
	Min	447	(64.8)	463	(67.2)		561	(81.3)	650	(94.3)	
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	286	(41.5)	294	(42.7)		370	(53.6)	465	(67.5)	
	Min	279	(40.5)	292	(42.4)		369	(53.5)	461	(66.8)	
Std. Deviation											
Elong, percent	Avg	20		24			19		10		
	Min	20		23			16		10		
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		2	(1)	2	(1)		2	(1)	2	(1)	
E, GN/m^2 (10^6 psi)	Avg	71.7	(10.4)	73.7	(10.7)		75.8	(11.0)	80.0	(11.6)	
	Min										
No. of Spec. (No. of Heats)		2	(1)	3	(1)		2	(1)	2	(1)	
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	396	(57.5)	406	(58.9)		470	(68.2)	589	(85.4)	
K_t = 6.3	Min	396	(57.5)				453	(65.7)	587	(85.1)	
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 90073, 90078

TABLE 4.2.3-ME3

Alloy Designation:	2024-T3 Aluminum Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T3

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	467 (67.8)	490 (71.0)	517 (75.0)	566 (82.1)		
	Min	459 (66.6)			565 (82.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	306 (44.4)	310 (45.0)	345 (50.0)	377 (54.7)		
	Min	303 (44.0)			372 (54.0)		
Std. Deviation							
Elong, percent	Avg	20.0	13.0	11.5	18.8		
	Min	20.0			11.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)	1	1	2 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	406 (58.9)	427 (62.0)	462 (67.0)	487 (70.6)		
K_t = 11.1	Min	399 (57.8)			470 (68.2)		
No. of Spec. (No. of Heats)		2 (2)	1	1	2 (2)		
NTS, MN/m^2 (ksi)	Avg	376 (54.6)			445 (64.6)		
K_t = 15.0	Min						
No. of Spec. (No. of Heats)		1			1		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 47334, 90188

TABLE 4.2.3-ME4

Alloy Designation:	2024-T86 Aluminum Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T86

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	523 (75.8)			629 (91.2)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	492 (71.3)			576 (83.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	5.2			8.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	444 (64.4)			449 (65.1)		
K_t = 11.1	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m^2 (ksi)	Avg	456 (66.2)			488 (70.8)		
K_t = 15	Min						
No. of Spec. (No. of Heats)		1			1		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90188

TABLE 4.2.3-ME5

Alloy Designation:	2024-T351 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T351

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	463 (67.1)				738 (107)	
	Min	456 (66.1)				724 (105)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	347 (50.3)				532 (77.2)	
	Min	343 (49.7)				523 (75.9)	
Std. Deviation							
Elong, percent	Avg	21.6				22.3	
	Min	20				17	
RA, percent	Avg	28.2				20.3	
	Min	23				18	
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	502 (72.8)				659 (95.6)	
K_t = 6.4	Min	481 (69.8)				574 (83.2)	
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64373

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TABLE 4.2.3-ME6

Alloy Designation:	2024-T4 Aluminum Alloy
Specification:	QQ-A-355
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	T4

Testing Temperature, K (F)		297	(75)	195	(-108)		77	(-320)	20	(-423)	
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	467	(67.7)	480	(69.6)		557	(80.8)	651	(94.4)	
	Min	451	(65.4)	474	(68.7)		546	(79.2)	632	(91.6)	
Std. Deviation		13.4	(1.45)				11.1	(1.61)	12.6	(1.82)	
TYS, MN/m^2 (ksi)	Avg	367	(53.3)	377	(54.7)		459	(66.5)	556	(80.6)	
	Min	359	(52.1)	370	(53.6)		445	(64.6)	550	(79.8)	
Std. Deviation		10.0	(1.45)				8.07	(1.17)	7.10	(1.03)	
Elong, percent	Avg	17.1		17.2			11.3		7.9		
	Min	11.5		15.5			6		5		
RA, percent	Avg	17		4			11		9		
	Min	12		2			11		5		
No. of Spec. (No. of Heats)		9	(2)	7	(2)		9	(2)	9	(2)	
E, GN/m^2 (10^6 psi)	Avg	(72.4)	(10.5)	73.1	(10.6)		75.2	(10.9)	80.0	(11.6)	
	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)		3	(1)	3	(1)	
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	478	(69.3)	508	(73.7)		581	(84.3)	672	(97.4)	
K_t = 6.3	Min	412	(59.8)	437	(63.4)		529	(76.7)	606	(87.9)	
No. of Spec. (No. of Heats)		9	(2)	7	(2)		9	(2)	9	(2)	
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	461	(66.9)	458	(66.4)		556	(80.6)	645	(93.6)	
	Min	457	(66.3)	450	(65.3)		554	(80.4)			
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	314	(45.5)	312	(45.2)		350	(50.7)	479	(69.4)	
	Min	312	(45.3)								
Std. Deviation											
Elong, percent	Avg	16		16			15		8		
	Min	16					12				
RA, percent	Avg	15		9			12		9		
	Min	15		5							
No. of Spec. (No. of Heats)		2	(1)	2	(1)		2	(1)	1		
E, GN/m^2 (10^6 psi)	Avg	73.1	(10.6)	73.1	(10.6)		76.5	(11.1)	79.3	(11.5)	
	Min										
No. of Spec. (No. of Heats)		1		1			1		1		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	525	(76.2)	534	(77.4)		620	(89.9)	655	(95)	
K_t = 6.3	Min	519	(75.3)	513	(74.4)		616	(89.4)	655	(95)	
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 51070, 90073, 90078

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TABLE 4.2.3-ME7

Alloy Designation:	2024-T851 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	T851

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	496 (72.0)	536 (77.8)		688 (99.8)		720 (104.4)
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	454 (65.8)	492 (71.3)		574 (83.3)		625 (90.7)
	Min						
Std Deviation							
Elong, percent	Avg	7.8	6.0		7.7		9.5
	Min						
RA, percent	Avg	17	14		13		14
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	578 (83.8)	581 (84.2)		623 (90.4)		733 (106.3)
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	488 (70.8)	524 (76.0)		605 (87.7)		
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	444 (64.4)	477 (69.2)		545 (79.0)		
	Min						
Std Deviation							
Elong, percent	Avg	7.2	6.8		7.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 72563, 80995

TABLE 4.2.3-ME8

Alloy Designation:		**2024-T4 Aluminum Alloy**											
Specification:													
Form:		**Bar**											
Thickness, cm (in.):		**Up to 2.540 (1.000)**											
Condition:		**T4**											
Testing Temperature, K (F)		297	(75)	195	(-108)	122	(-240)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal													
TUS, MN/m^2 (ksi)	Avg	488	(70.8)	502	(72.8)	538	(78.0)	616	(89.4)	752	(109)	738	(107)
	Min	483	(70.0)	488	(70.8)			600	(87.0)	752	(109)		
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg	363	(52.6)	365	(52.9)	379	(55.0)	470	(68.1)	586	(85)	524	(76)
	Min	345	(50.0)	354	(51.4)			441	(64.0)	586	(85)		
Std. Deviation													
Elong, percent	Avg	20.2		20.8		20.0		18.8		17.5		20.0	
	Min	19.5		20.0				15.0		15.0			
RA, percent	Avg	29.7		25.8		22.6		18.1		18.6		20.8	
	Min	26.6		24.3				16.5		18.0			
No. of Spec. (No. of Heats)		3	(2)	3	(2)	1		3	(2)	2	(1)	1	
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
Tension, Transverse													
TUS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
Elong, percent	Avg												
	Min												
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)													
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													

References: 35611, 47334

TABLE 4.2.3-ME9

Alloy Designation:	2024-T4 Aluminum Alloy
Specification:	
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	T4

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	12.8 (9.4)	12.2 (9.0)	10.1 (7.4)	8.7 (6.4)		
	Min						
No. of Spec. (No. of Heats)		1	1	1	1		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 47334

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.2.3-ME10

Alloy Designation: 2024-T86 Aluminum Alloy

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: T86

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	512 (74.2)	552 (80.0)		633 (91.8)	723 (104.9)	
	Min	510 (73.9)	551 (79.9)		628 (91.1)	720 (104.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	494 (71.6)	526 (76.3)		590 (85.6)	643 (93.2)	
	Min	493 (71.5)	525 (76.1)		590 (85.5)	641 (93.0)	
Std. Deviation							
Elong, percent	Avg	9.5	9.4		10.7	15.1	
	Min	9.3	9.1		10.6	14.6	
RA, percent	Avg	26.6	23.2		21.4	24.4	
	Min	25.7	22.3		20.8	23.1	
No. of Spec. (No. of Heats)		4 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 54986

TABLE 4.2.3-ME11

Alloy Designation:	2024-T86 Aluminum Alloy
Specification:	
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	T86

Testing Temperature, K (F)		297 (75)		195	(-108)		77	(-320)		
Compression, Longitudinal										
CYS, MN/m² (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m² (10⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m² (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m² (10⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear(a)										
SUS, MN/m² (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m² (10⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., Nm(ft-lb)	Avg	4.8	(3.5)	4.1	(3.0)		4.8	(3.5)		
	Min	4.1	(3.0)	4.1	(3.0)		4.8	(3.5)		
No. of Spec. (No. of Heats)		4	(1)	4	(1)		3	(1)		
Trans., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness(b)										
K_{Ic} MN/m$^{3/2}$(ksi√in.)	Avg									
	Min									
Orientation: –										
No. of Spec. (No. of Heats)										
K_{IE}, MN/m$^{3/2}$(ksi√in.)	Avg									
(From PTSC spec.)(–)	Min									
No. of Spec. (No. of Heats)										

References: 54986

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

17.1<

TABLE 4.2.3-ME12

Alloy Designation: 2024-T351 Aluminum Alloy

Specification:
Form: Bar
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: T351

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	479 (69.4)			610 (88.5)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	365 (53.0)			478 (69.3)		
	Min						
Std. Deviation							
Elong, percent	Avg	19.5			19.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	562 (81.5)			682 (98.9)		
K_t = 2.4	Min	507 (73.6)			599 (86.9)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg	518 (75.2)			625 (90.6)		
K_t = 13.3	Min	479 (69.5)			553 (80.2)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	472 (68.4)			594 (86.1)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	327 (47.4)			428 (62.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	17.2			14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	544 (78.9)			654 (94.8)		
K_t = 2.4	Min	499 (72.4)			576 (83.6)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg	497 (72.1)			595 (86.3)		
K_t = 13.3	Min	463 (67.2)			545 (79.1)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		

References: 90188

TABLE 4.2.3-TR1

Alloy Designation: 2024-0 Aluminum Alloy

Specification:
Form:
Dimension:
Condition: (0)

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	184	158	150	77.9	39.5	
Btu hr^{-1} ft^{-1} F^{-1}	(106)	(91.4)	(86.7)	(45.0)	(22.8)	
No. of Spec.	1	1	1	1	1	
References: 90195						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.303	-0.342	-0.348	-0.348	-0.348
No. of Spec.	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	3.26×10^{-8}	1.15×10^{-8}	0.700×10^{-8}	0.608×10^{-8}	0.605×10^{-8}	0.605×10^{-8}
Ohm circular mil ft^{-1}	(19.6)	(6.92)	(4.21)	(3.66)	(3.64)	(3.64)
No. of Spec.	13	13	13	13	13	13
References: 90164, 90195						

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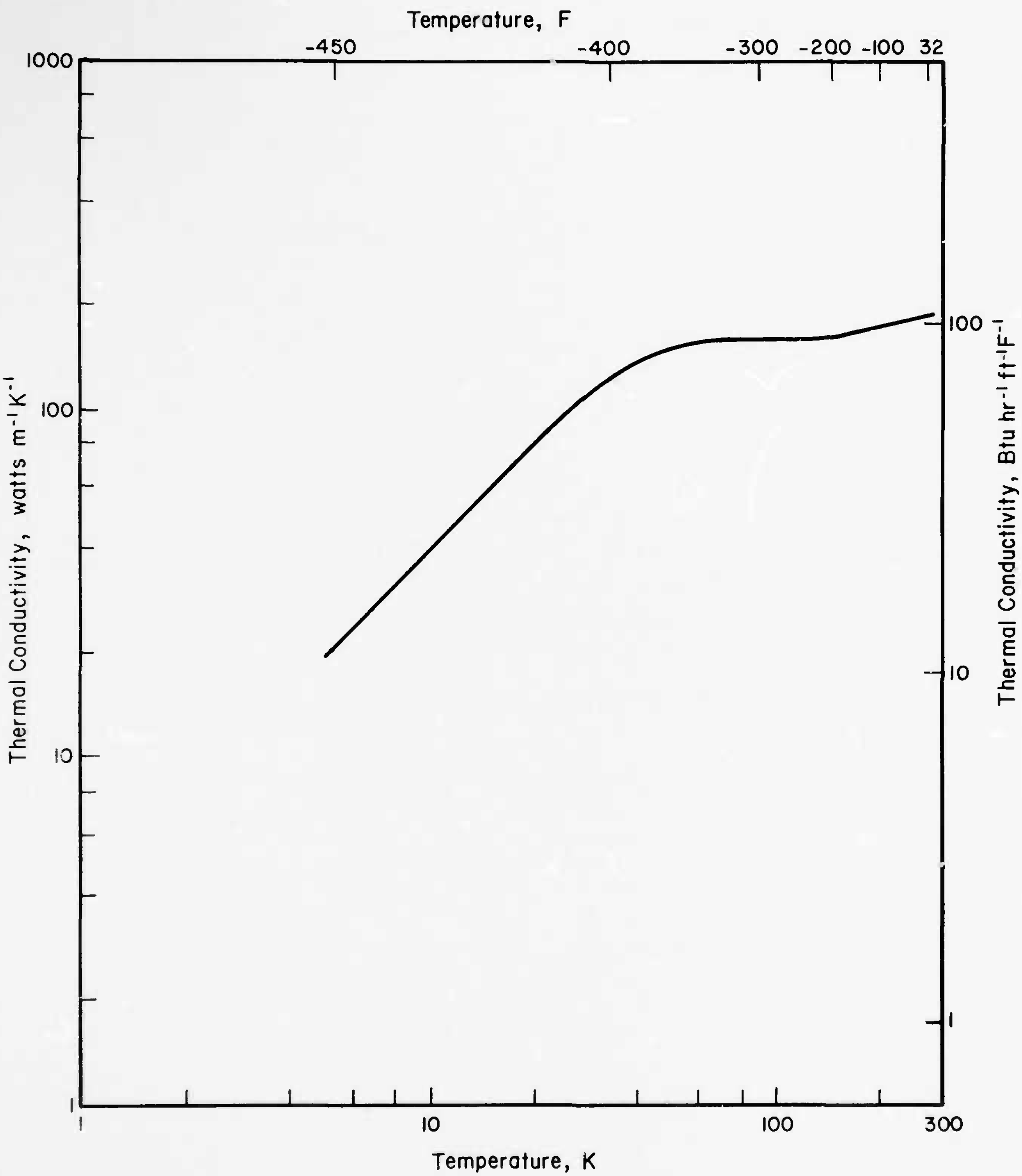

FIGURE 4.2.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-0

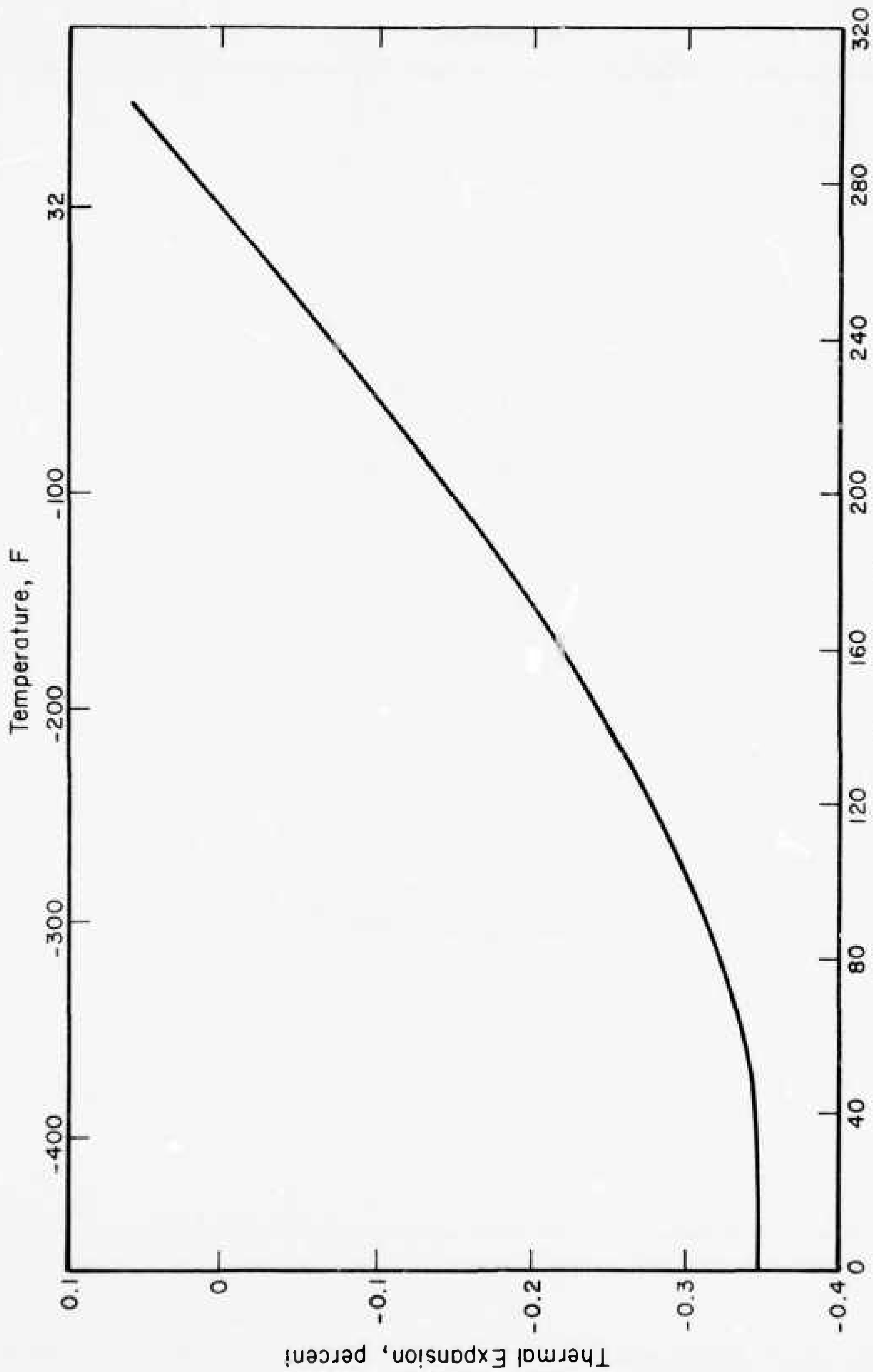

FIGURE 4.2.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-0

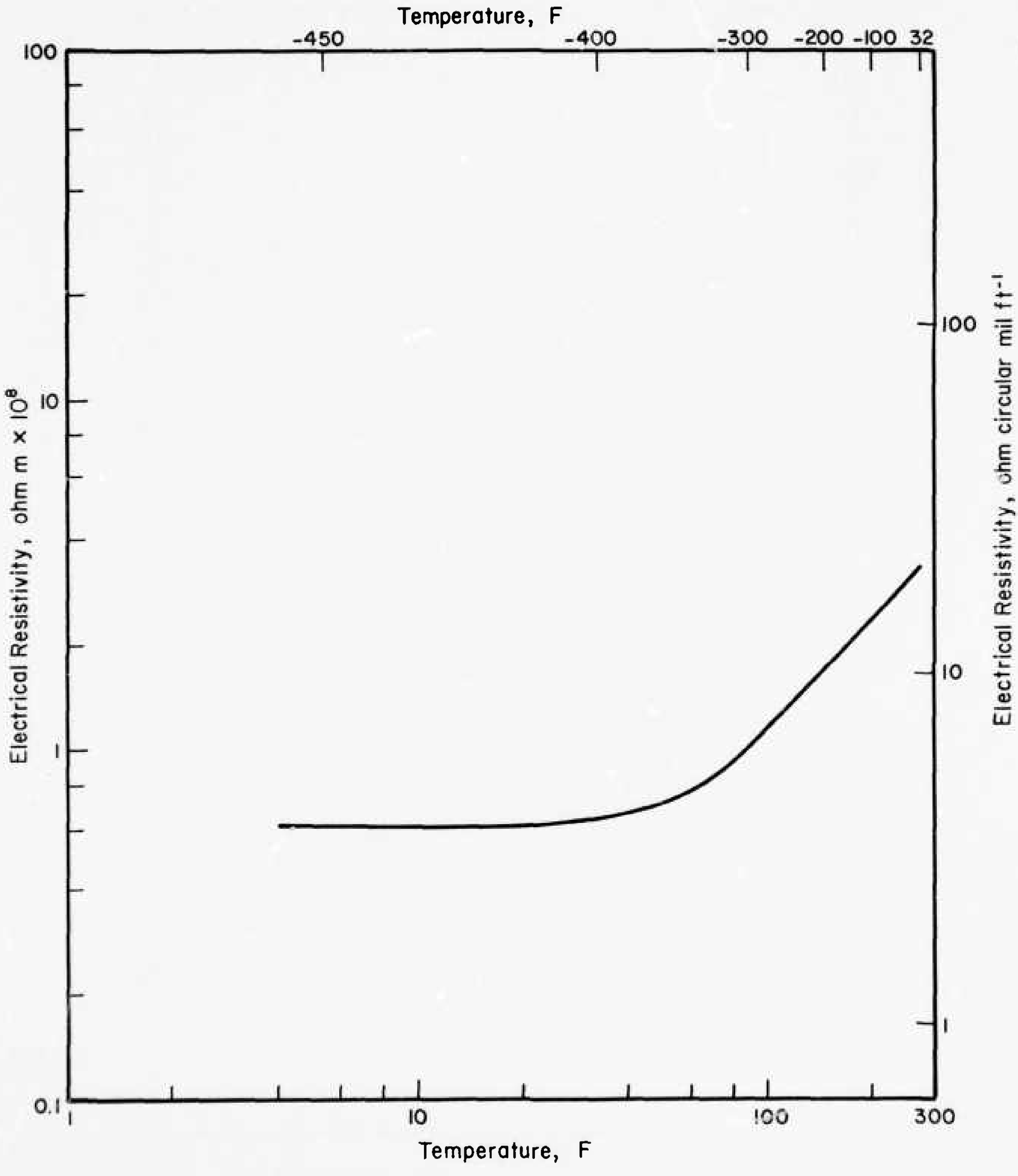

FIGURE 4.2.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-0

TABLE 4.2.3-TR2

Alloy Designation: 2024-T4 Aluminum Alloy

Specification:
Form:
Dimension:
Condition: T4

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}			64.5		39.0		17.0		8.32		3.15	
Btu hr^{-1} ft^{-1} F^{-1}				(37.3)		(22.6)		(9.83)		(4.81)		(1.82)
No. of Spec			1		1		1		1		1	
References: 90225												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}	828		530									
Btu lb^{-1} F^{-1}		(0.198)		(0.127)								
No. of Spec	2		2									
References: 90223												
Electrical Resistivity												
Ohm m	5.54×10^{-8}		3.60×10^{-8}		3.20×10^{-8}		3.08×10^{-8}		3.08×10^{-8}		3.08×10^{-8}	
Ohm circular mil ft^{-1}		(33.3)		(21.6)		(19.2)		(18.5)		(18.5)		(18.5)
No. of Spec.	5		5		5		5		5		5	
References: 90164												

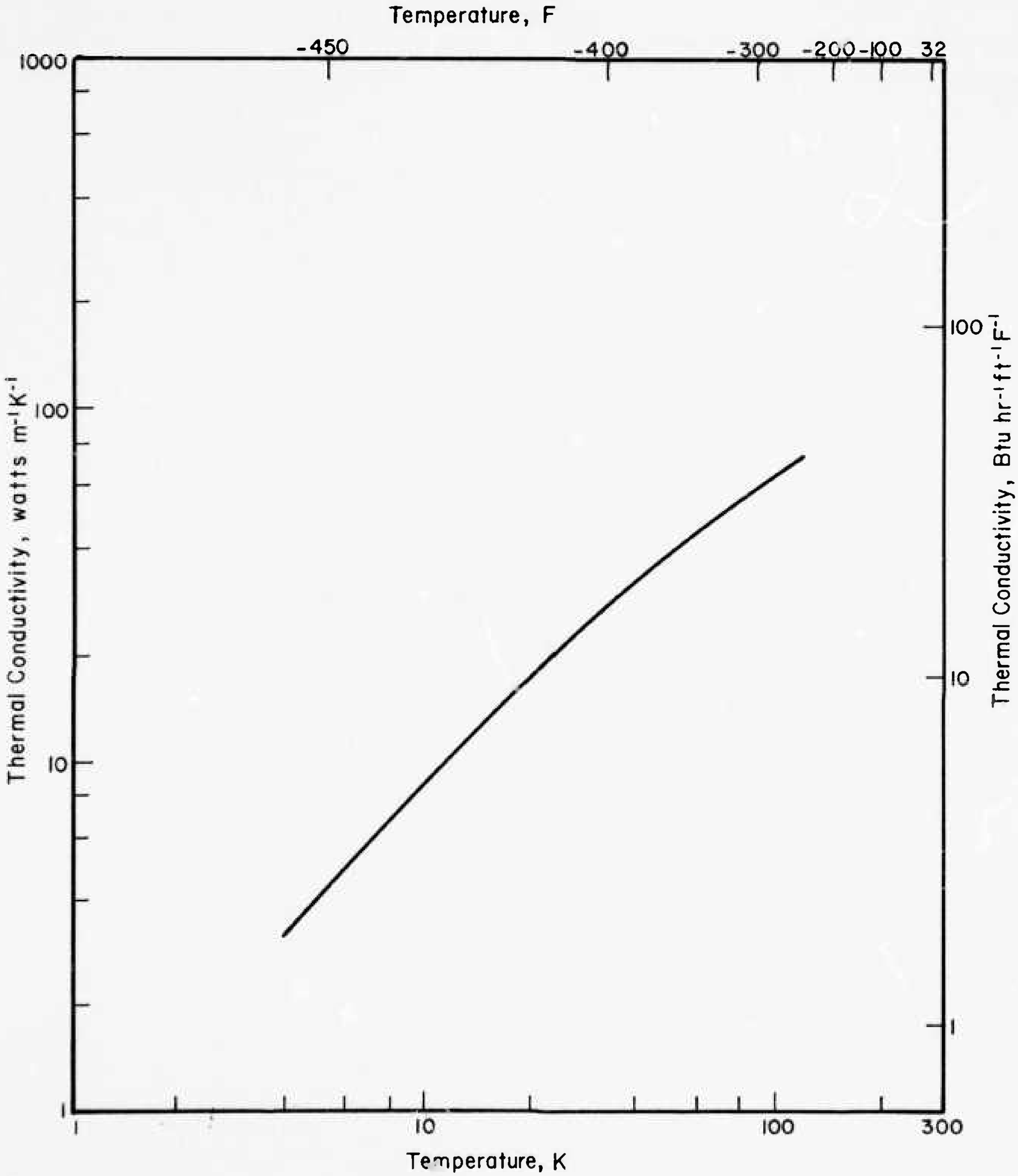

FIGURE 4.2.3-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T4

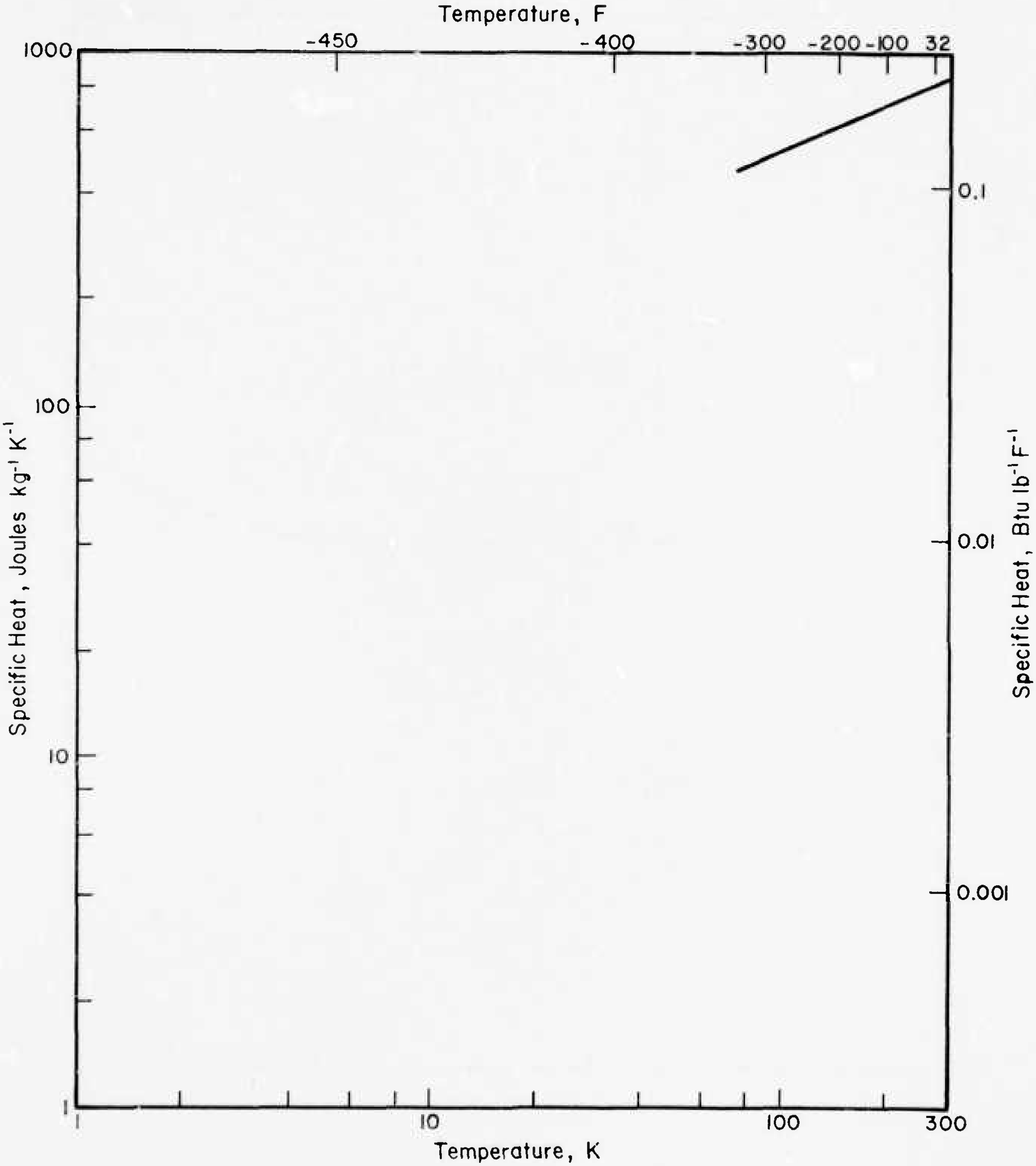

FIGURE 4.2.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T4

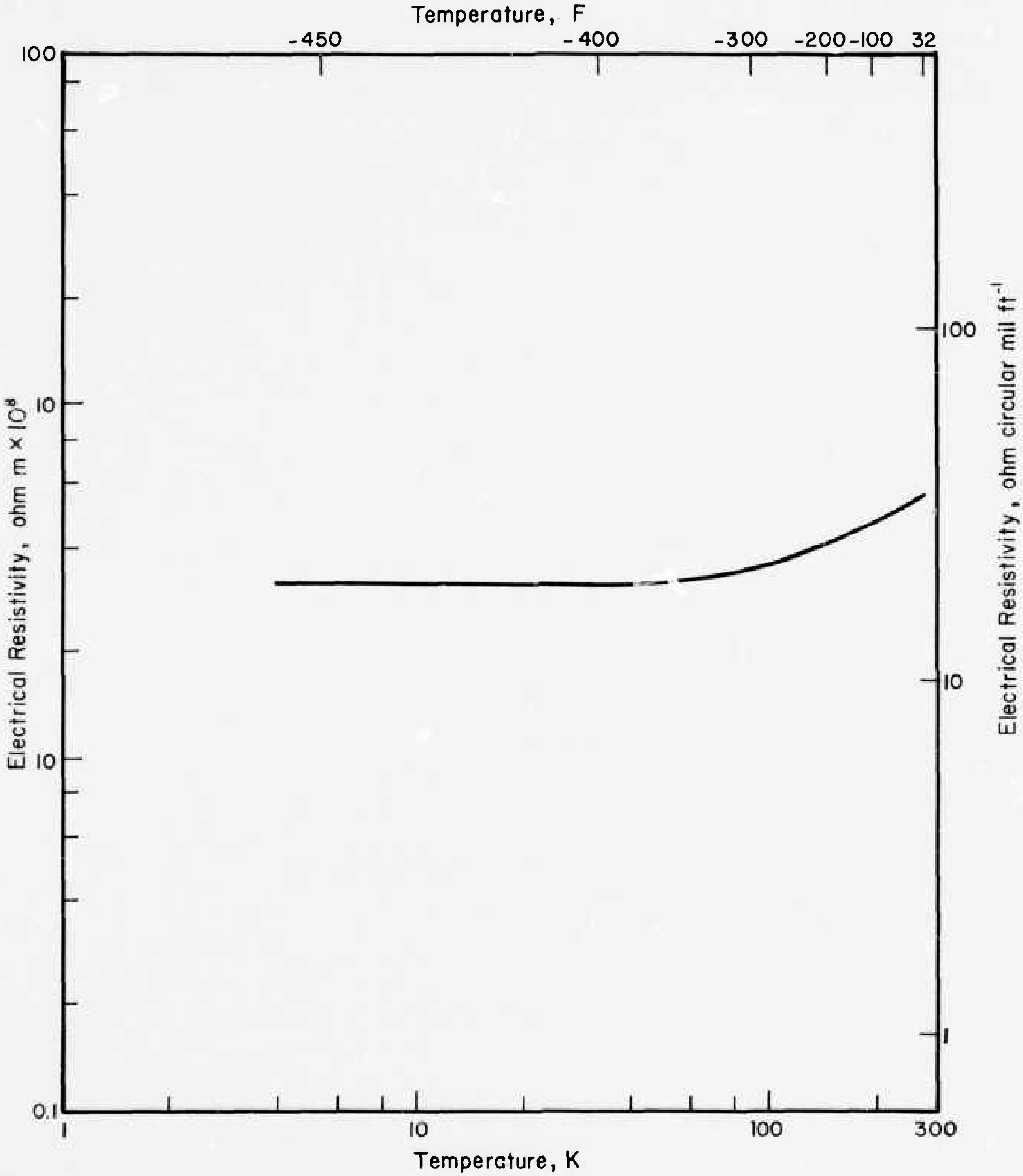

FIGURE 4.2.3-R2. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T4

TABLE 4.2.3-TR3

Alloy Designation: 2024-T6 Aluminum Alloy

Specification:
Form:
Dimension:
Condition: T6

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec						
References:						
Electrical Resistivity						
Ohm m	4.61×10^{-8}	2.47×10^{-8}	2.05×10^{-8}	1.99×10^{-8}	1.93×10^{-8}	1.98×10^{-8}
Ohm circular mil ft^{-1}	(27.7)	(14.9)	(12.3)	(12.0)	(11.9)	(11.9)
No. of Spec	3	3	3	3	3	3
References: 90164						

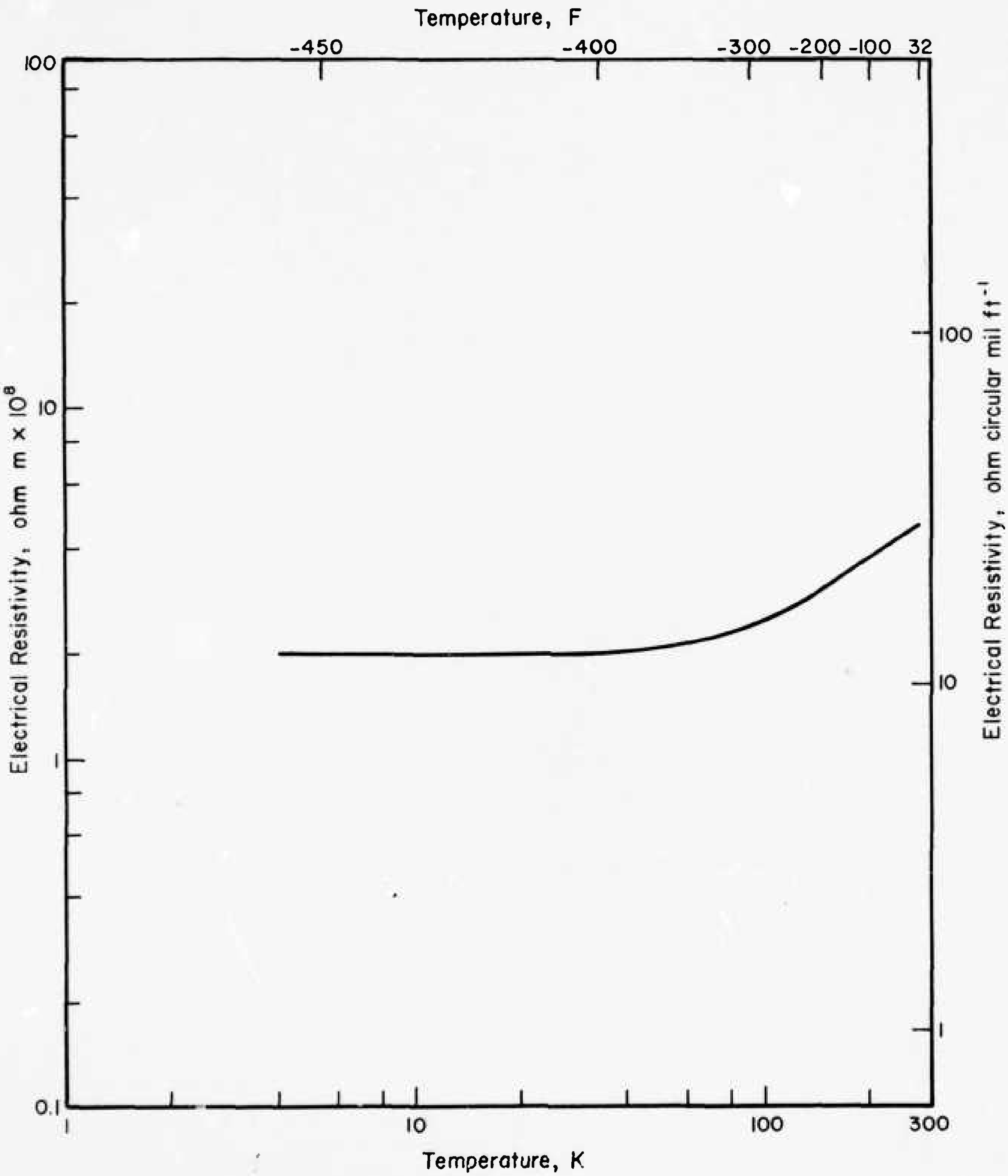

FIGURE 4.2.3-R3. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T6

TABLE 4.2.3-TR4

Alloy Designation: 2024-T86 Aluminum Alloy

Specification:
Form:
Dimension:
Condition: T86

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	150	101	71.1	31.8	15.7	
Btu hr^{-1} ft^{-1} F^{-1}	(86.5)	(58.4)	(41.1)	(18.4)	(9.08)	
No. of Spec.	1	1	1	1	1	
References: 90195						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.308	-0.348	-0.353	-0.353	-0.353
No. of Spec.	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	4.22×10^{-8}	2.13×10^{-8}	1.69×10^{-8}	1.59×10^{-8}	1.59×10^{-8}	1.59×10^{-8}
Ohm circular mil ft^{-1}	(25.4)	(12.8)	(10.2)	(9.56)	(9.56)	(9.56)
No. of Spec.	2	2	2	2	2	2
References: 90164, 90195						

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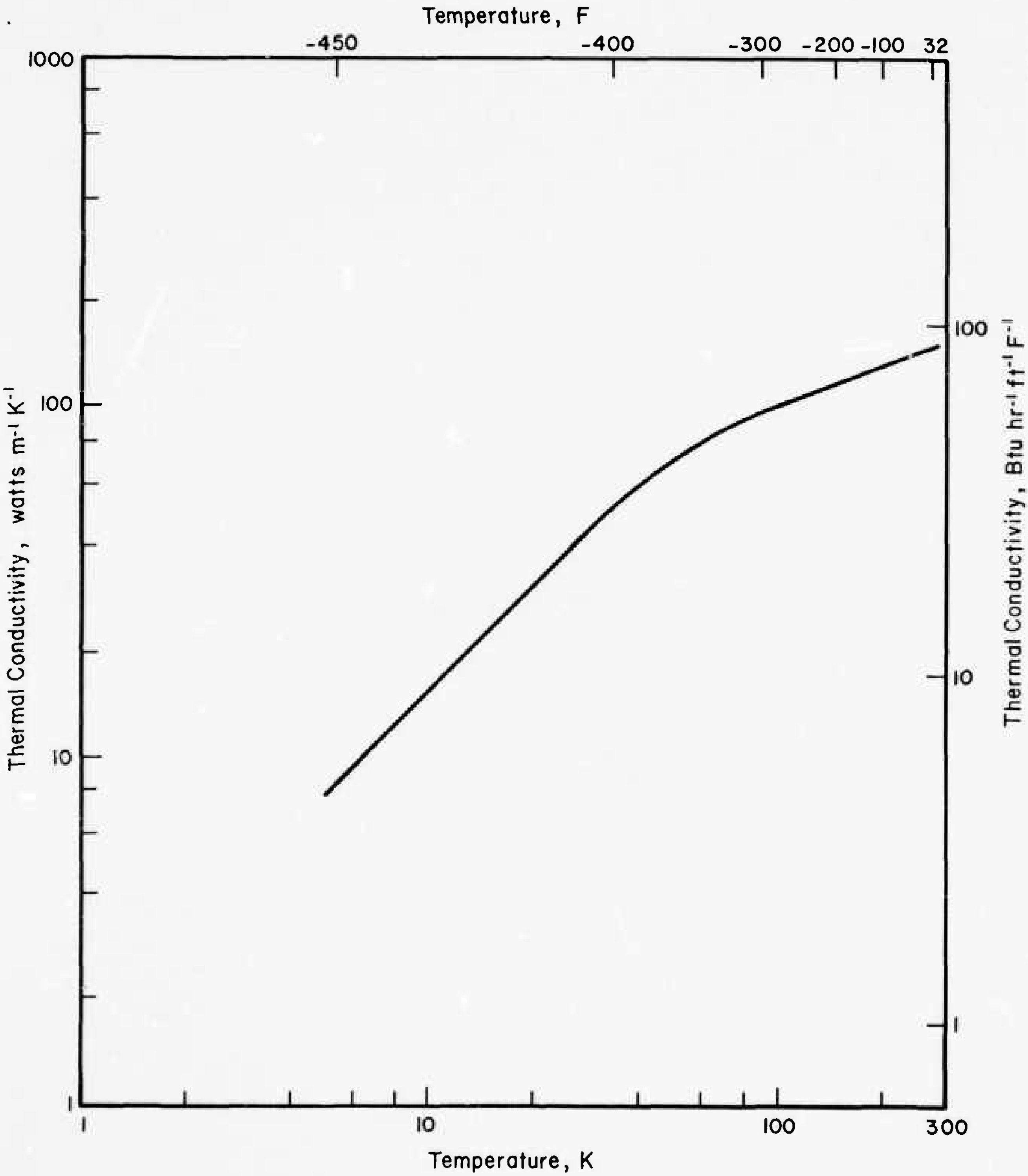

FIGURE 4.2.3-C3. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T86

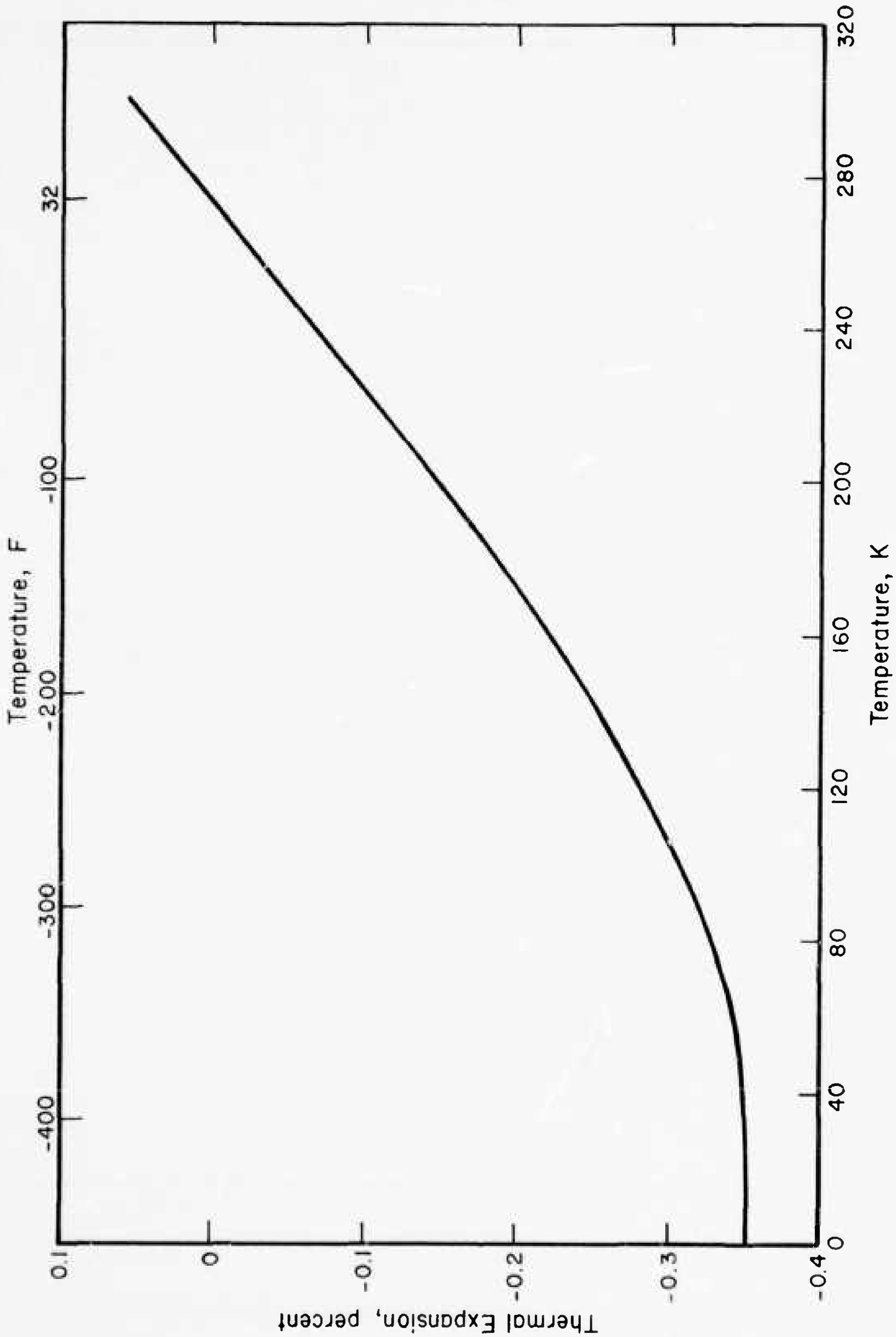

FIGURE 4.2.3-E2. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T86

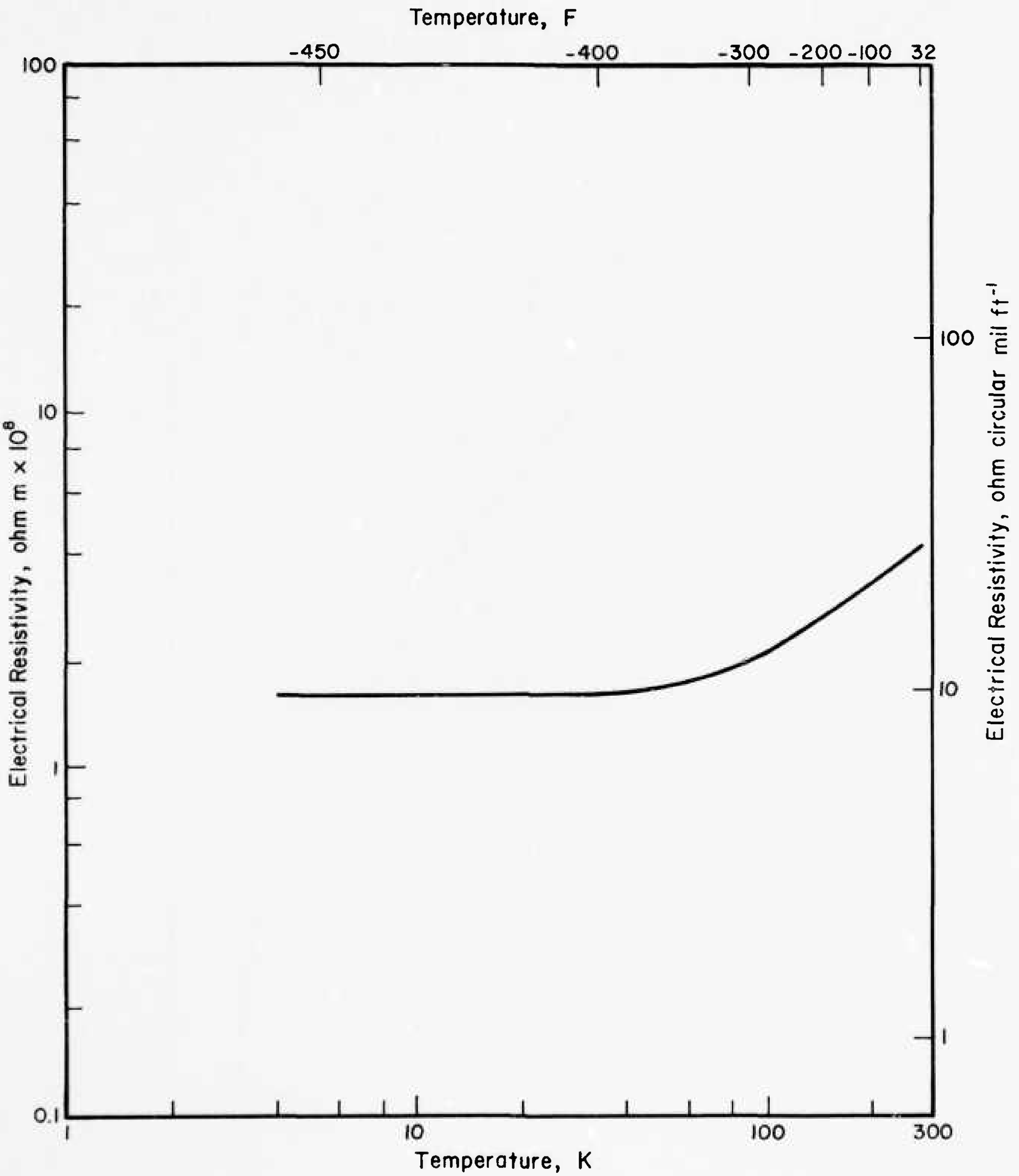

FIGURE 4.2.3-R4. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T86

TABLE 4.3.1-ME2.1

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: 5083-H113 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	285 (41.3)			409 (59.3)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	141 (20.4)			177 (25.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	16.3			21.9		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			9 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90083

TABLE 4.3.1-ME2.2

Alloy Designation:	5083 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	5083-H113 Plate, tested as welded

Testing Temperature, K (F)	297 (76)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	141 (20.5)			171 (24.8)		
Loading frequency Hz						
with R = -1 and K_t =						
No. of S-N Curves (No. of Heats)	2 (1)			2 (1)		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	89.6 (13.0)			130 (18.8)		
Loading frequency Hz						
with R = -1 and K_t =						
No. of S-N Curves (No. of Heats)	2 (1)			2 (1)		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)	60.3 (8.75)			98.6 (14.3)		
Loading frequency Hz						
with R = -1 and K_t =						
No. of S-N Curves (No. of Heats)	2 (1)			2 (1)		
Ratio S_N/TUS at 10^7 cycles						

References: [illegible]083

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TABLE 4.3.1-ME3

Alloy Designation: 5083-O Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Annealed (0)

Testing Temperature, K (F)		297 (75)	144 (-200)	116 (-250)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	319 (46.3)	347 (50.3)	376 (54.6)	436 (63.3)	587 (85.2)	557 (80.8)
	Min	314 (45.5)			425 (61.7)	582 (84.4)	556 (80.6)
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	143 (20.7)	142 (20.6)	150 (21.7)	159 (23.0)	174 (25.2)	179 (25.8)
	Min	138 (20.0)			154 (22.4)	172 (25.0)	179 (25.8)
Std. Deviation							
Elong, percent	Avg	20.2	31.4	33.1	34.4	32	32
	Min	18.0			31.0	30	32
RA, percent	Avg	29.3	45.6	43.2	36.2	24.3	33.1
	Min	22			29	24	31.7
No. of Spec. (No. of Heats)		13 (4)	6 (1)	6 (1)	12 (4)	3 (1)	3 (1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	354 (51.4)			409 (59.4)	409 (59.3)	430 (62.3)
K_t = 14	Min	330 (47.8)			393 (57.0)	406 (59.0)	419 (60.8)
No. of Spec. (No. of Heats)		6 (2)			5 (2)	3 (1)	3 (1)
NTS, MN/m^2 (ksi)	Avg	336 (48.8)	376 (54.5)	387 (56.2)	408 (59.2)		
K_t = 15	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	316 (45.8)	340 (49.3)	367 (53.3)	426 (62.8)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	143 (20.7)	144 (20.9)	150 (21.8)	160 (23.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	23.3	31.3	32.9	34.1		
	Min						
RA, percent	Avg	32.7	40.4	38.8	34.3		
	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	323 (46.8)	359 (52.0)	372 (53.9)	388 (56.3)		
K_t = 15	Min						
No. of Spec. (No. of Heats)		6 (1)	6 (1)	6 (1)	6 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39134, 48561, 90187, 90190

TABLE 4.3.1-ME3.1

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	116	(-250)	77	(-320)	4	(-452)
Tension, Longitudinal													
TUS, MN/m^2 (ksi)	Avg	301	(43.7)	303	(43.9)	337	(48.9)	372	(54.0)	416	(60.4)	381	(55.3)
	Min	293	(42.5)							401	(58.2)		
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg	151	(21.9)	143	(20.7)	161	(23.4)	169	(24.5)	175	(25.4)	174	(25.2)
	Min	139	(28.1)							154	(22.4)		
Std. Deviation													
Elong, percent	Avg	18.4		31.0		21.6		29.5		20.8		27.0	
	Min	17.4								19.0			
RA, percent	Avg	33.7		44		31.3		37.5		22.0		37	
	Min									20			
No. of Spec. (No. of Heats)		4	(2)	1		3	(1)	3	(1)	4	(2)	1	
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg	314	(45.5)	344	(49.9)	349	(50.6)	370	(53.6)	365	(52.9)	372	(53.9)
K_t = 15-16	Min	308	(44.7)							345	(50.1)		
No. of Spec. (No. of Heats)		4	(2)	1		3	(1)	3	(1)	4	(2)	1	
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
Tension, Transverse													
TUS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
Elong, percent	Avg												
	Min												
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)													
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													

References: 90072, 90187

TABLE 4.3.1-ME3.2

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5556 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5083-H113 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	284 (41.2)			414 (60.1)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	146 (21.2)			170 (24.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	12.5			20.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48787

TABLE 4.3.1-ME3.3

Alloy Designation:	5083 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5556 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	5083-H113 Plate, tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	193 (28.0)			221 (32.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	138 (20.0)			179 (26.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 48787

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TABLE 4.3.1-ME3.4

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	305 (44.2)	324 (47.0)		446 (64.7)		456 (66.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	179 (26.0)	181 (26.2)		217 (31.4)		246 (35.7)
	Min						
Std. Deviation							
Elong, percent	Avg	14.0	19.0		19.0		9.0
	Min						
RA, percent	Avg	39	48		23		14
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	376 (54.5)	410 (59.5)		430 (62.4)		405 (58.8)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.3.1-ME3.5

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5356 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	286 (41.5)	303 (43.9)		427 (61.9)		455 (66.0)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	168 (24.3)	186 (27.0)		201 (29.1)		235 (34.1)
	Min						
Std. Deviation							
Elong, percent	Avg	13.5	14.5		15.5		9.0
	Min						
RA, percent	Avg	47	52		33		17
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	371 (53.8)	396 (57.5)		418 (60.6)		398 (57.7)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.3.1-ME3.6

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5556 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	306 (44.4)	319 (46.3)		450 (65.3)		474 (68.8)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	177 (25.6)	184 (26.7)		211 (30.6)		239 (34.6)
	Min						
Std. Deviation							
Elong, percent	Avg	14.0	18.5		20.5		13.0
	Min						
RA, percent	Avg	36	46		26		17
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	370 (53.7)	401 (58.1)		417 (60.5)		399 (57.9)
K_t = 16	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 90072

TABLE 4.3.1-ME3.7

Alloy Designation: 5083-O Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	295 (42.8)			419 (60.8)		
	Min	280 (40.6)			405 (58.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	146 (21.2)			177 (25.6)		
	Min	129 (18.7)			160 (23.2)		
Std. Deviation							
Elong, percent	Avg	22.5			24.5		
	Min	17.7			20.8		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (1)			10 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 96684

TABLE 4.3.1-ME3.8

Alloy Designation: 5083-O Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5356 Alloy filler
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	291 (42.2)			407 (59.1)		
	Min	288 (41.7)			387 (56.2)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	145 (21.2)			172 (24.9)		
	Min	142 (20.6)			171 (24.8)		
Std. Deviation							
Elong, percent	Avg	17.9			23.2		
	Min	16.1			20.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96694

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TABLE 4.3.1-ME4. RESULTS OF ALCOA ANALYSIS FOR DEVELOPMENT OF MAXIMUM ALLOWABLE DESIGN STRESSES[a] FOR 5083-0 SHEET AND PLATE AT CRYOGENIC TEMPERATURES (90174)

Testing Temperature		Min. TUS		Min. TUS/4		Min. TYS		Min. TYS x 2/3		Design Stress	
K	F	MN/m^2	Ksi	MN/m^2	Ksi	MN/m^2	Ksi	MN/m^2	Ksi	MN/m^2	Ksi
				Thickness 0.130 to 3.810 cm (0.051 to 1.500 in.)							
297	75	276	40.0	69.0	10.0	124	18.0	82.7	12.0	69.0	10.0
255	0	276	40.0	69.0	10.0	124	18.0	82.7	12.0	69.0	10.0
227	-50	276	40.0	69.0	10.0	124	18.0	82.7	12.0	69.0	10.0
200	-100	278	40.4	69.6	10.1	124	18.0	82.7	12.0	69.6	10.1
172	-150	285	41.4	71.7	10.4	126	18.3	84.1	12.2	71.7	10.4
144	-200	302	43.8	75.8	11.0	129	18.7	86.2	12.5	75.8	11.0
117	-250	332	48.2	82.7	12.0	133	19.3	88.9	12.9	82.7	12.0
111	-260	340	49.3	84.8	12.3	134	19.4	88.9	12.9	84.8	12.3
89	-300	368	53.3	91.7	13.3	136	19.8	91.0	13.2	91.0	13.2
77	-320	381	55.2	95.2	13.8	138	20.1	92.4	13.4	92.4	13.4
				Thickness 3.811 to 7.620 cm (1.501 to 3.000 in.)							
297	75	269	39.0	66.9	9.7	117	17.0	77.9	11.3	66.9	9.7
255	0	269	39.0	66.9	9.7	117	17.0	77.9	11.3	66.9	9.7
227	-50	270	39.1	67.6	9.8	117	17.0	77.9	11.3	67.6	9.8
200	-100	272	39.4	67.6	9.8	117	17.0	77.9	11.3	67.6	9.8
172	-150	278	40.4	69.6	10.1	118	17.2	79.3	11.5	69.6	10.1
144	-200	294	42.7	73.8	10.7	121	17.6	80.7	11.7	73.8	10.7
117	-250	324	47.0	81.4	11.8	125	18.2	83.4	12.1	81.4	11.8
111	-260	332	48.1	82.7	12.0	126	18.3	84.1	12.2	82.7	12.0
89	-300	358	52.0	89.6	13.0	129	18.7	86.2	12.5	86.2	12.5
77	-320	371	53.8	92.4	13.4	130	18.9	86.9	12.6	86.9	12.6
				Thickness 7.621 to 12.700 cm (3.001 to 5.000 in.)							
297	75	262	38.0	65.5	9.5	110	16.0	73.8	10.7	65.5	9.5
255	0	262	38.0	65.5	9.5	110	16.0	73.8	10.7	65.5	9.5
227	-50	263	38.1	65.5	9.5	110	16.0	73.8	10.7	65.5	9.5
200	-100	265	38.4	66.2	9.6	110	16.0	73.8	10.7	66.2	9.6
172	-150	272	39.4	67.6	9.8	112	16.2	74.5	10.8	67.2	9.8
144	-200	287	41.6	71.7	10.4	114	16.6	76.5	11.1	71.7	10.4
117	-250	316	45.8	78.6	11.4	118	17.1	78.6	11.4	78.6	11.4
111	-260	323	46.8	80.7	11.7	118	17.2	79.3	11.5	79.3	11.5
89	-300	350	50.7	87.6	12.7	121	17.6	80.7	11.7	80.7	11.7
77	-320	362	52.5	90.3	13.1	123	17.8	82.0	11.9	82.0	11.9

(a) Allowable design stresses are determined on the basis of the lower of (1) one-fourth of the minimum tensile strength or (2) two-thirds of the minimum yield strength. Classical statistical methods were not used in reduction of the data.

TABLE 4.3.1-ME8

Alloy Designation:	5083-0 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Annealed (0)

Testing Temperature, K (F)		297	(75)	110	(-260)	77	(-320)			
Tension, Longitudinal										
TUS, MN/m^2 (ksi)	Avg	297	(43.1)	383	(55.5)	412	(59.7)			
	Min	273	(39.6)			374	(54.3)			
Std. Deviation										
TYS, MN/m^2 (ksi)	Avg	132	(19.1)	151	(21.9)	148	(21.5)			
	Min	121	(17.6)			141	(20.5)			
Std. Deviation										
Elong, percent	Avg	22.3		31.7		30.1				
	Min	15.0				15				
RA, percent	Avg	26.8		37.0		29.5				
	Min	14				19				
No. of Spec. (No. of Heats)		9	(4)	3	(2)	9	(4)			
E, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Poisson's Ratio										
Work Hardening Coef										
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										
Tension, Transverse										
TUS, MN/m^2 (ksi)	Avg	294	(42.7)	396	(57.4)	387	(56.1)			
	Min	262	(38.0)			351	(50.9)			
Std. Deviation										
TYS, MN/m^2 (ksi)	Avg	133	(19.3)	157	(22.7)	150	(21.8)			
	Min	121	(17.5)			141	(20.4)			
Std. Deviation										
Elong, percent	Avg	18.3		29.8		22.5				
	Min	14				15.5				
RA, percent	Avg	22.7		28.7		23.2				
	Min	14				17				
No. of Spec. (No. of Heats)		11	(4)	3	(2)	8	(4)			
E, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Poisson's Ratio										
Work Hardening Coef										
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										

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References: 90176, 96690, 96691

TABLE 4.3.1-ME9

Alloy Designation: 5083-0 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Annealed (0)

Testing Temperature, K (F)		297 (75)	110 (-260)	77 (-320)			
Tension, Short Transverse							
TUS, MN/m^2 (ksi)	Avg	268 (38.8)	323 (46.8)	332 (48.1)			
	Min	245 (35.6)		316 (45.8)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	127 (18.4)	156 (22.6)	144 (20.9)			
	Min	116 (16.8)		135 (19.6)			
Std. Deviation							
Elong, percent	Avg	11.0	10.0	11.38			
	Min	10		9.5			
RA, percent	Avg	11.5	11.0	12.0			
	Min	11		11			
No. of Spec. (No. of Heats)		5 (3)	(1)	5 (3)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90176, 96691

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TABLE 4.3.1-ME9.1

Alloy Designation:	5083 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (76)		111 (-260)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	283 (41.0)		368 (53.4)	394 (57.1)		
	Min	247 (35.8)		339 (49.2)	341 (49.4)		
Std. Deviation		17.7 (2.57)			29.9 (4.34)		
TYS, MN/m^2 (ksi)	Avg	159 (23.0)		181 (26.3)	185 (26.8)		
	Min	144 (20.9)		160 (23.2)	167 (24.2)		
Std. Deviation		9.38 (1.36)			12.6 (1.82)		
Elong, percent	Avg	15.4		18.9	18.3		
	Min	6.5		11.0	9.8		
RA, percent	Avg	22.4		24.8	20.1		
	Min	12		16	14		
No. of Spec. (No. of Heats)		12 (3)		6 (2)	12 (3)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 90176, 96690

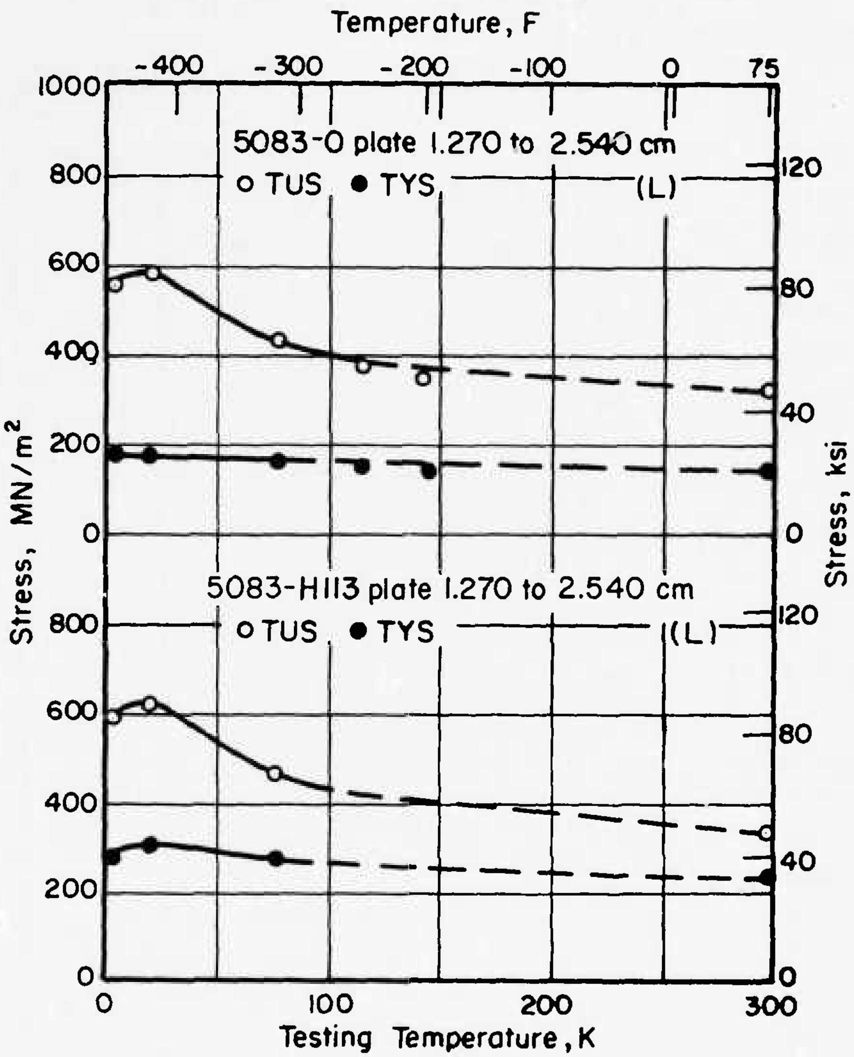

FIGURE 4.3.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 5083 ALUMINUM ALLOY

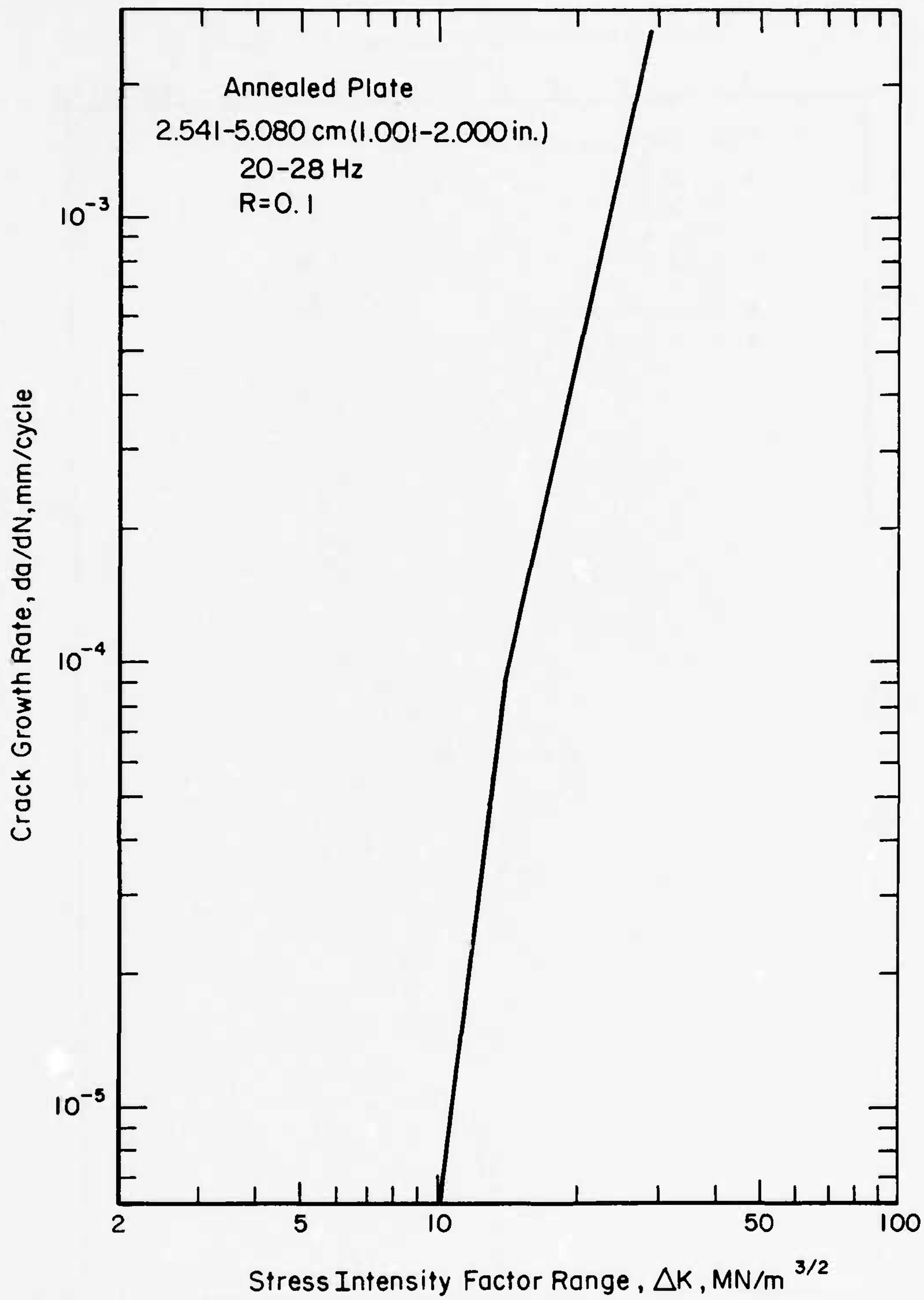

FIGURE 4.3.1-ME2. FATIGUE-CRACK GROWTH RATE OF 5083-0 ALUMINUM ALLOY AT 4 K (94208D)

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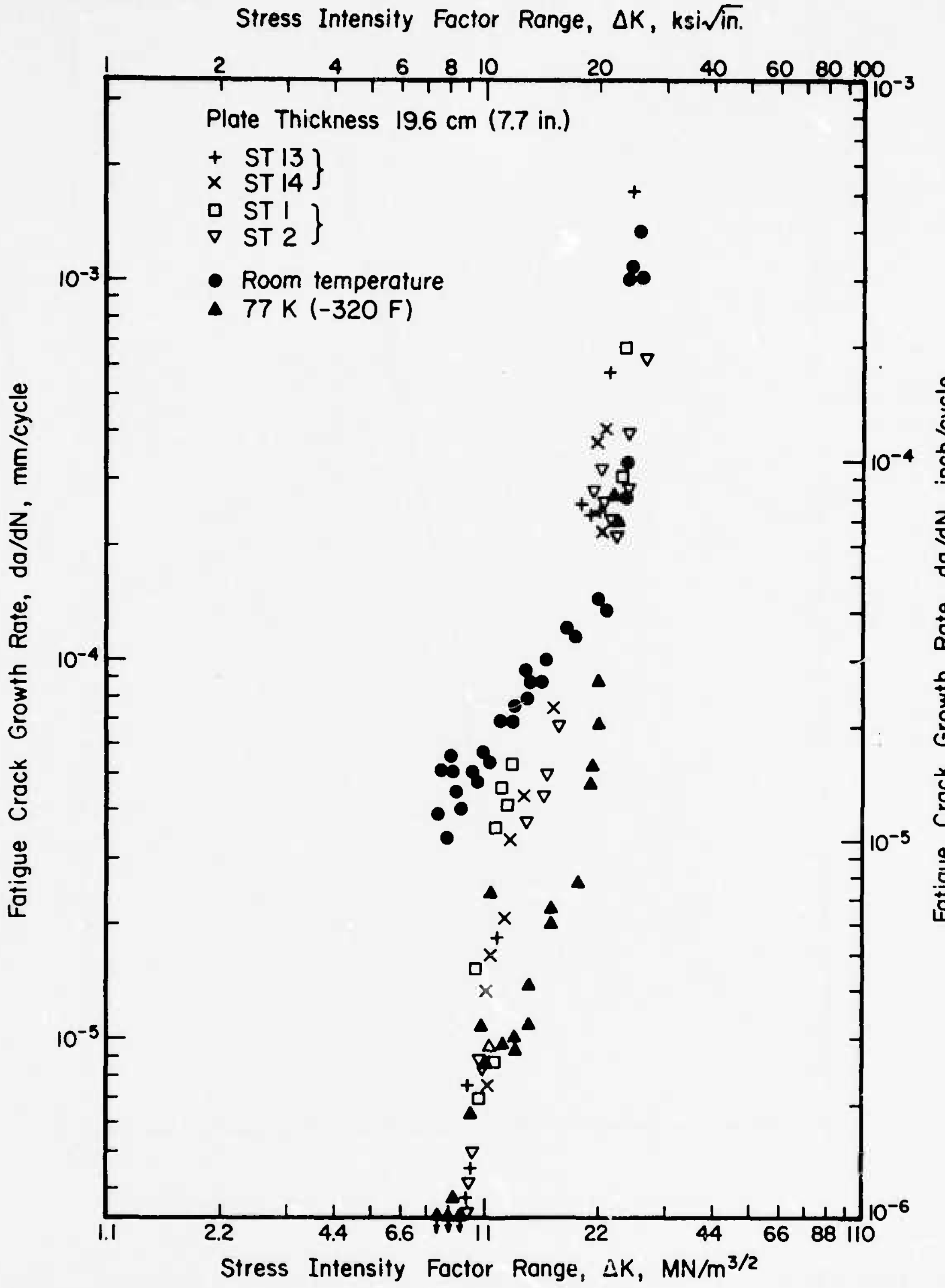

FIGURE 4.3.1-ME3. FATIGUE CRACK GROWTH RATE OF 5083-O ALUMINUM ALLOY PLATE [90175, 96691]

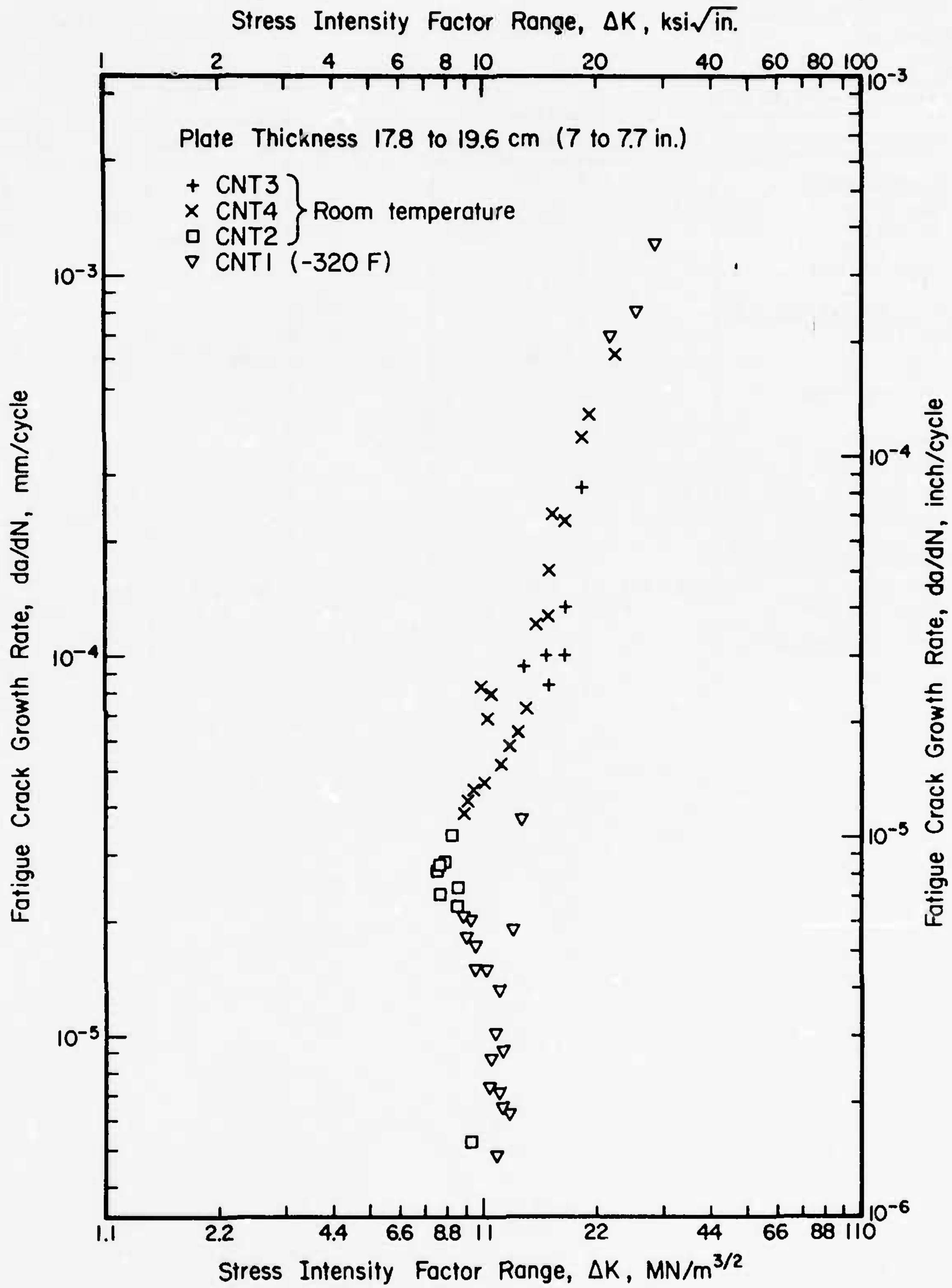

FIGURE 4.3.1-ME4. FATIGUE CRACK GROWTH RATE OF 5083-O ALUMINUM PLATE MIG WELDED (5183 ALLOY FILLER) [90175]

TABLE 4.3.1-TR1

Alloy Designation: 5083-O Aluminum Alloy

Specification:
Form:
Dimension:
Condition: Annealed (-0), H113

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity (-0)						
Watts m^{-1} K^{-1}		62	38	17.3	8.5	
Btu hr^{-1} ft^{-1} F^{-1}		(35.8)	(22.0)	(10.0)	(4.9)	
No. of Spec.		1	1	1	1	
References: 90225						
Thermal Expansion (T_{273} to T) Longitudinal (-H113)						
Percent	0	-0.32	-0.36	-0.365	-0.365	
No. of Spec.	1	1	1	1	1	
References: 74405						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity (-0, -H113)						
Ohm m	5.70×10^{-8}	3.60×10^{-8}	3.20×10^{-8}	3.05×10^{-8}	3.05×10^{-8}	3.05×10^{-8}
Ohm circular mil ft^{-1}	(34.3)	(21.7)	(19.3)	(1.76)	(1.76)	(1.76)
No. of Spec.	4	4	4	4	4	4
References: 79561, 90164						

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TABLE 4.3.2-ME1

Alloy Designation: 5456-0 Aluminum Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: 0

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	351 (50.9)				587 (85.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	183 (26.5)				210 (30.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	16.8				24.8	
	Min						
RA, percent	Avg	26.1				25.4	
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	332 (48.1)				307 (44.5)	
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)				4 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	323 (46.9)			440 (63.8)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	177 (25.7)			200 (29.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	24.2			40.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1					
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	287 (41.6)			296 (43.0)		
K_t = 11.1	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m^2 (ksi)	Avg	274 (39.7)			305 (44.3)		
K_t = 15	Min						
No. of Spec. (No. of Heats)		1			1		

References: 56755, 90188

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TABLE 4.3.2-ME2

Alloy Designation: 5456-H24 Aluminum Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: H24

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	376 (54.5)			518 (75.1)	596 (86.4)	
	Min					589 (85.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	289 (41.9)			382 (55.4)	389 (56.4)	
	Min					379 (55.0)	
Std. Deviation							
Elong, percent	Avg	13.7			13.2	7.7	
	Min					7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	5 (1)	
E, GN/m^2 (10^6 psi)	Avg				80.0 (11.6)	88.3 (12.8)	
	Min						
No. of Spec. (No. of Heats)					1	1	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	376 (54.6)			475 (68.9)	571 (82.8)	
	Min					557 (80.8)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	274 (39.8)			330 (47.9)	384 (55.7)	
	Min					384 (55.7)	
Std. Deviation							
Elong, percent	Avg	11.6			8.9	8.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)			2 (2)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	343 (49.7)			331 (48.0)		
K_t = 11.1	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m^2 (ksi)	Avg	313 (45.4)			325 (47.2)		
K_t = 15	Min						
No. of Spec. (No. of Heats)		1			1		

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References: 42002, 90188

TABLE 4.3.2-ME3

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, 4043 Alloy filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: 5456-H24 TIG welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	341 (49.4)			409 (59.3)	372 (54.0)	
	Min					353 (51.2)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	10 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	351 (50.9)			411 (59.6)	387 (56.1)	
	Min					372 (54.0)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	4 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 42002

TABLE 4.3.2-ME4

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	H321

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	396 (57.4)			528 (76.6)	665 (96.4)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	272 (39.5)			322 (46.7)	363 (52.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	14.5			26.8	21.7	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	328 (47.6)			363 (52.7)	392 (56.9)	
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	399 (57.9)			500 (72.5)	613 (88.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	273 (39.6)			322 (46.7)	373 (54.1)	
	Min						
Std. Deviation							
Elong, percent	Avg	17.5			23.5	14.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	332 (48.2)			366 (53.1)	389 (56.4)	
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90076

TABLE 4.3.2-ME5

Alloy Designation:	5456 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 5556 Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	5456-H321 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	358 (32.6)			439 (63.7)	407 (59.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	225 (32.6)			260 (37.7)	341 (49.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	13.0			15.8	3.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	375 (54.4)			412 (59.7)	412 (59.7)	
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	375 (51.7)			435 (63.1)	428 (62.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	209 (30.3)			247 (35.8)	379 (55.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.5			9.5	5.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	357 (51.8)			394 (57.1)	384 (55.7)	
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 90076

TABLE 4.3.2-ME6

Alloy Designation: 5456-H343 Aluminum Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: H343

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal													
TUS, MN/m^2 (ksi)	Avg	395	(57.3)	401	(58.2)	427	(62.0)	510	(73.9)	592	(85.9)		(86.5)
	Min	389	(56.4)	393	(57.0)			488	(70.8)	554	(80.4)		
Std. Deviation		5.31	(0.77)					10.0	(1.45)	26.6	(3.86)		
TYS, MN/m^2 (ksi)	Avg	323	(46.8)	344	(49.9)	324	(47.0)	377	(54.7)	412	(59.8)		(57.0)
	Min	298	(43.2)	310	(45.0)			348	(50.5)	372	(53.9)		
Std. Deviation		19.9	(2.88)					23.7	(8.43)	33.4	(4.84)		
Elong, percent	Avg	8.4		9.9		11.7		11.5		9.4		9.5	
	Min	7.0		9.3				7.0		8.0			
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)		9	(3)	6	(2)	1		9	(3)	9	(3)	1	
E, GN/m^2 (10^6 psi)	Avg	71.7	(10.4)	73.8	(10.7)			73.8	(10.7)	77.9	(11.3)		
	Min	70.3	(10.2)	69.6	(10.1)			70.3	(10.2)	75.2	(10.9)		
No. of Spec. (No. of Heats)		6	(2)	5	(1)			6	(2)	6	(2)		
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg	405	(58.8)					489	(70.9)	542	(78.6)		
K_t = 3.5	Min	402	(58.3)					485	(70.4)	535	(77.6)		
No. of Spec. (No. of Heats)		3	(1)					3	(1)	3	(1)		
NTS, MN/m^2 (ksi)	Avg	393	(57.0)	394	(57.2)			444	(64.4)	472	(68.5)		
K_t = 6.3	Min	390	(56.6)	392	(56.8)			442	(64.1)	463	(67.1)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)			5	(1)	5	(1)		
Tension, Transverse													
TUS, MN/m^2 (ksi)	Avg	403	(58.4)	401	(58.1)			499	(72.4)	566	(82.1)		
	Min	401	(58.1)	394	(57.2)			496	(72.0)	527	(76.4)		
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg	297	(43.1)	302	(43.8)			356	(51.7)	390	(56.5)		
	Min	296	(43.0)	299	(43.3)			348	(50.6)	376	(54.5)		
Std. Deviation													
Elong, percent	Avg	9.7		11.2				12.0		7.7			
	Min	9.5		10.5				11.5		5.0			
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)		5	(1)	5	(1)			5	(1)	5	(1)		
E, GN/m^2 (10^6 psi)	Avg	70.3	(10.2)	73.1	(10.6)			73.1	(10.6)	80.7	(11.7)		
	Min	69.0	(56.7)	383	(55.6)			394	(57.2)	413	(59.9)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)			5	(1)	5	(1)		
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg	395	(57.3)	392	(56.9)			410	(59.4)	422	(61.2)		
K_t = 6.3	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													

References: 48652, 58060, 61996

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TABLE 4.3.2-ME7

Alloy Designation:	5456 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 5356 Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	5456-H343 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	365 (53.0)	363 (52.6)		471 (68.3)	457 (66.3)	
	Min	363 (52.6)	360 (52.2)		469 (68.0)	439 (63.7)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	4.9	4.9		9.0	2.5	
	Min	4.5	4.5		9.0	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	354 (51.4)	348 (50.4)		450 (65.3)	459 (66.6)	
	Min	353 (51.2)	281 (40.8)		441 (64.0)	440 (63.8)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	4.2	4.6		7.4	3.2	
	Min	3.5	4.5		6.0	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48652

TABLE 4.3.2-ME8

Alloy Designation:	5456 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 5556 Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	5456-H343 welded and tested

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal													
TUS, MN/m^2 (ksi)	Avg	342	(49.6)	328	(47.5)	368	(53.4)	422	(61.2)	403	(58.5)	443	(64.2)
	Min	330	(47.9)					399	(57.8)	364	(52.8)		
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg	199	(28.7)	207	(30.0)	214	(31.0)	240	(34.8)	272	(39.5)	264	(38.3)
	Min												
Std. Deviation													
Elong, percent	Avg	4.6		5.3		6.3		6.9		3.5		4.3	
	Min												
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)		6	(2)	3	(1)	3	(1)	6	(2)	9	(2)	3	(1)
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
Tension, Transverse													
TUS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
Elong, percent	Avg												
	Min												
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)													
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													

References: 58060, 61996

TABLE 4.3.2-ME9

Alloy Designation: 5456-0 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)
Condition: 0

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	351 (50.9)				587 (85.1)	
	Min	346 (50.2)				583 (84.6)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	183 (26.5)				210 (30.5)	
	Min	179 (25.9)				203 (29.5)	
Std. Deviation							
Elong, percent	Avg	16.8				24.8	
	Min	16.0				23.5	
RA, percent	Avg	26.1				25.5	
	Min	26.0				22.9	
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	332 (48.1)				305 (44.3)	
K_t = 6.3	Min	325 (47.2)				305 (44.3)	
No. of Spec. (No. of Heats)		4 (1)				2 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 66080

TABLE 4.3.2-ME10

Alloy Designation:	5456-0 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	0

Testing Temperature, K (F)		297 (75)				20 (-423)	
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg	210 (30.4)				407 (59.0)	
	Min						
No. of Spec. (No. of Heats)		7 (1)				7 (1)	
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 56754

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.3.2-ME11

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: H321

Testing Temperature, K (F)		297 (75)				20 (-423)	
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg	228 (33.0)				443 (64.3)	
	Min						
No. of Spec. (No. of Heats)		7 (1)				7 (1)	
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 56754

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.3.2-ME12

Alloy Designation:	5456-0 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	338 (49.0)	339 (49.1)		455 (66.0)		203 (29.5)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	160 (23.2)	163 (23.6)		180 (26.1)		203 (29.5)
	Min						
Std. Deviation							
Elong, percent	Avg	21.8	26.5		34.5		30.7
	Min						
RA, percent	Avg	31	43		35		24
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	351 (50.9)			411 (59.6)		420 (60.9)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

221< **References:** 72563

TABLE 4.3.2-ME13

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: H321

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	353 (51.2)	379 (55.0)		492 (71.3)	636 (92.2)	638 (92.6)
	Min	339 (49.2)			475 (68.9)	622 (90.2)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	235 (34.1)	236 (34.3)		275 (39.9)	303 (43.9)	321 (46.5)
	Min	225 (32.7)			273 (39.6)	273 (39.6)	
Std. Deviation							
Elong, percent	Avg	13.5	20.5		25.8	18.2	23.6
	Min	11			24.5	14	
RA, percent	Avg	11.3	31		28	16.8	25
	Min	7				15	
No. of Spec. (No. of Heats)		7 (3)	1		2 (2)	5 (1)	1
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	411 (59.6)				461 (66.8)	
K_t = 6.4	Min	403 (58.4)				392 (56.8)	
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
NTS, MN/m² (ksi)	Avg	412 (59.7)			456 (66.2)		523 (75.8)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1			1		1
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48787, 64373, 72563

222<

TABLE 4.3.2-ME14

Alloy Designation:	5456-H321 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	H321

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	290 (42.0)			324 (47.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	248 (36.0)			283 (41.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 48787

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TABLE 4.3.2-ME15

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5556 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5456-H321 Plate, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	308 (44.6)			407 (59.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	155 (22.5)			181 (26.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	13.0			14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 48787

TABLE 4.3.2-ME16

Alloy Designation:	5456 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5556 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	5456-H321 Plate, welded and tested

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	207 (30.0)			241 (35.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	159 (23.0)			209 (30.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 48787

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TABLE 4.3.2-ME17

Alloy Designation:	5456-H343 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	H343

Testing Temperature, K (F)		297 (75)	196 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	387 (56.1)	383 (55.6)	416 (60.3)	497 (72.1)	516 (74.8)	
	Min	385 (55.9)			491 (71.2)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	306 (44.4)	308 (44.6)	326 (47.3)	361 (52.3)	378 (54.8)	
	Min	305 (44.2)			360 (52.2)		
Std. Deviation							
Elong, percent	Avg	10.2	12.5	15.5	13.9	7.0	
	Min	10.0			11.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	1	1	3 (1)	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	367 (53.3)	360 (52.2)	373 (54.1)	422 (61.2)		
K_t = 13.2	Min			372 (54.0)			
No. of Spec. (No. of Heats)		1	1	2 (1)	1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90184

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TABLE 4.3.2-ME18

Alloy Designation:	5456 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5356 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	5456-H343 Plate, welded and tested

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)	
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	270	(39.1)	269	(39.0)	300	(43.5)	319	(46.3)	319	(46.2)	
	Min	242	(35.1)	250	(36.2)	275	(39.9)	304	(44.1)	290	(42.1)	
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	177	(25.6)	184	(26.7)	194	(28.1)	210	(30.5)	228	(33.1)	
	Min	170	(24.6)	184	(26.7)	183	(26.5)	200	(29.0)	217	(31.5)	
Std. Deviation												
Elong, percent	Avg	4.5		5.8		6.0		4.9		4.0		
	Min	3.5		5.5		5.0		4.8		3.5		
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		3	(1)	2	(1)	2	(1)	3	(1)	3	(1)	
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
Elong, percent	Avg											
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 90184

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TABLE 4.3.2-ME19

Alloy Designation:	5456 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, 5356 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	5456-H343 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	287 (41.6)	315 (45.7)	299 (43.4)	352 (51.1)	345 (50.0)	
	Min	251 (36.4)	314 (45.5)	283 (41.1)	296 (42.9)	326 (47.3)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	181 (26.3)	179 (25.9)	192 (27.8)	214 (31.0)	228 (33.0)	
	Min	178 (25.8)	172 (25.0)	185 (26.8)	206 (29.9)	223 (32.4)	
Std. Deviation							
Elong, percent	Avg	6.5	8.5	6.3	5.5	4.0	
	Min	5.0	7.0	6.0	3.0	3.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	2 (1)	4 (1)	4 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 90184

TABLE 4.3.2-ME20

Alloy Designation:	5456-H321 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	H321

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	382 (55.4)			506 (73.4)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	247 (35.8)			288 (41.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	13.2			26.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	430 (62.4)			558 (81.0)		
K_t = 2.4	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg	412 (59.7)			486 (70.5)		
K_t = 13.3	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	382 (55.4)			483 (70.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	230 (33.3)			259 (37.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	16.5			25.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	430 (62.3)			541 (78.4)		
K_t = 2.4	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg	405 (58.7)			472 (68.4)		
K_t = 13.3	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		

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References: 90188

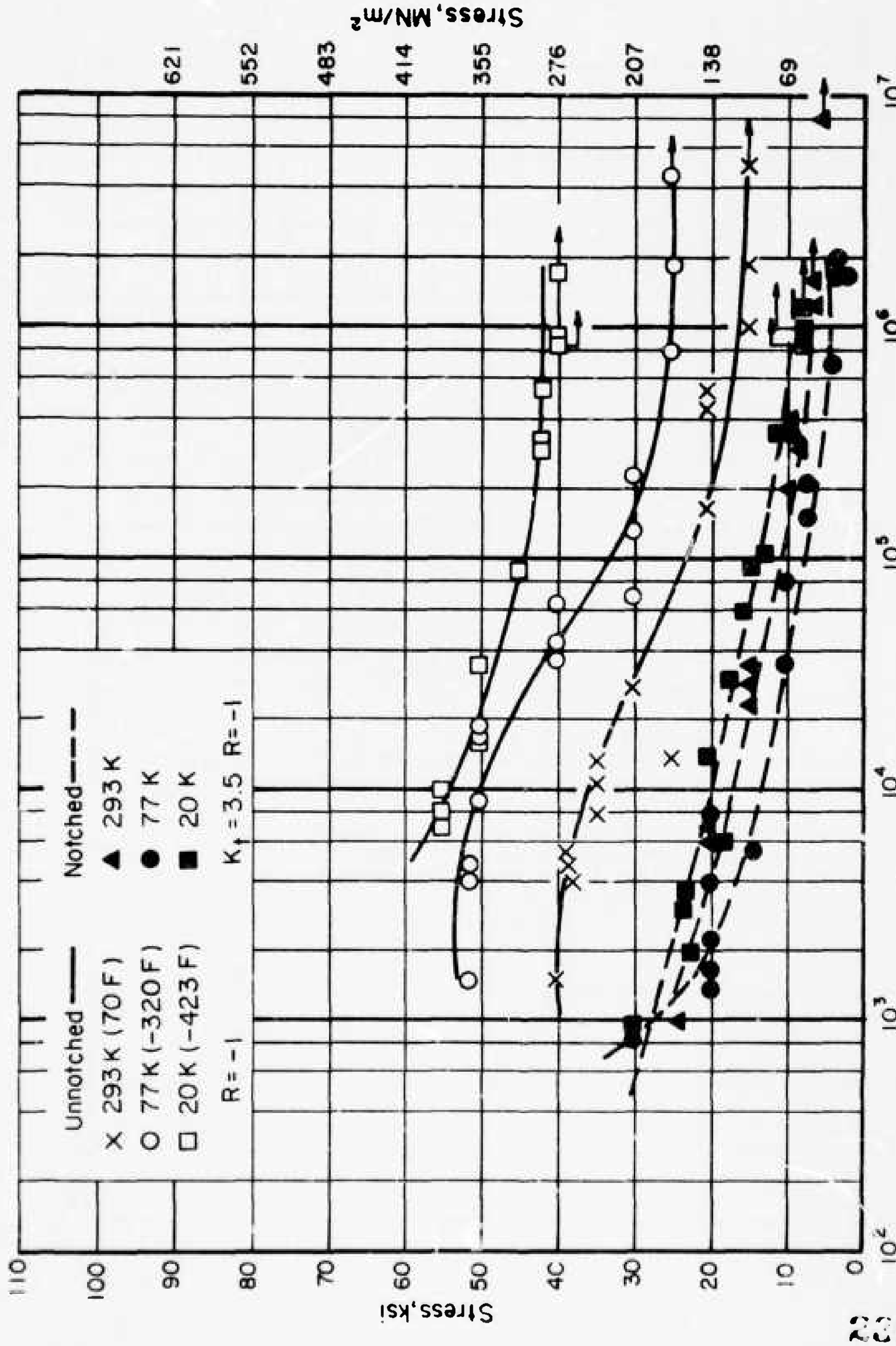

FIGURE 4.3.2-ME1. FATIGUE LIFE CURVES FOR AXIAL LOADING ON SMOOTH SPECIMENS OF 5456-H343 ALUMINUM ALLOY SHEET 0.254 cm (0.100 in.) THICK AT CYCLIC FREQUENCY OF 1833 Hz AT R = -1 [61996]

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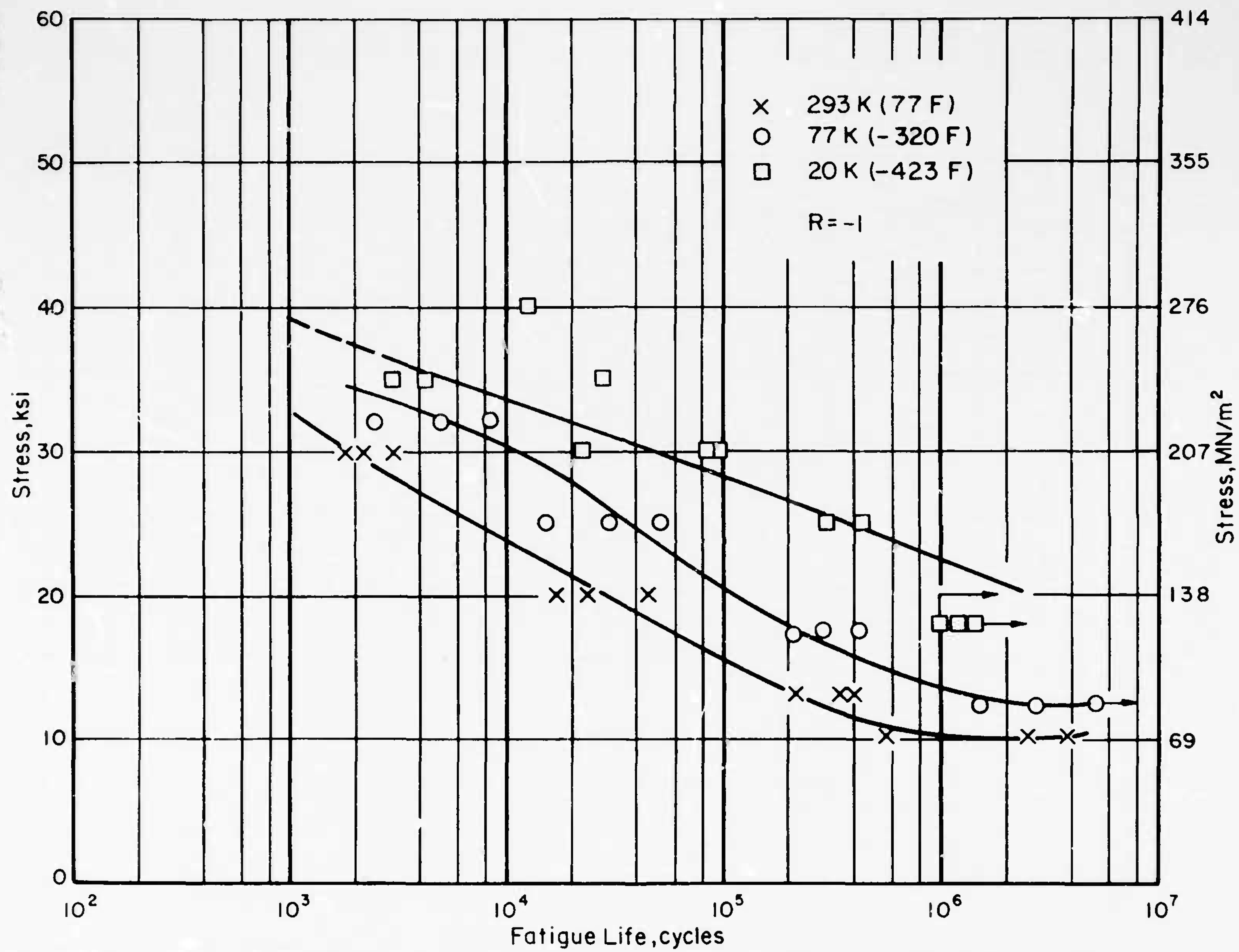

FIGURE 4.3.2-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING ON SPECIMENS OF 5456-H343 ALUMINUM ALLOY SHEET 0.254 cm (0.100 in.) THICK, TIG WELDED (5556 ALLOY FILLER) AND TESTED AT CYCLIC FREQUENCY OF 1833 Hz [61996]

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TABLE 4.3.2-TR1

Alloy Designation:	5456-H343 Aluminum Alloy
Specification:	
Form:	
Dimension:	
Condition:	H343

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	109	64.0	44.0	27.0		
Btu hr^{-1} ft^{-1} F^{-1}	(63.0)	(37.0)	(25.4)	(15.6)		
No. of Spec.	1	1	1	1		
References: 90218						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0.00	-0.332	-0.364	-0.367	-0.367	-0.367
No. of Spec.	1	1	1	1	1	1
References: 48571						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	5.92×10^{-8}	3.80×10^{-8}	3.35×10^{-8}	3.26×10^{-8}	3.26×10^{-8}	3.26×10^{-8}
Ohm circular mil ft^{-1}	(35.6)		(22.9)	(19.6)	(19.6)	(19.6)
No. of Spec.	1	1	1	1	1	1
References: 90164						

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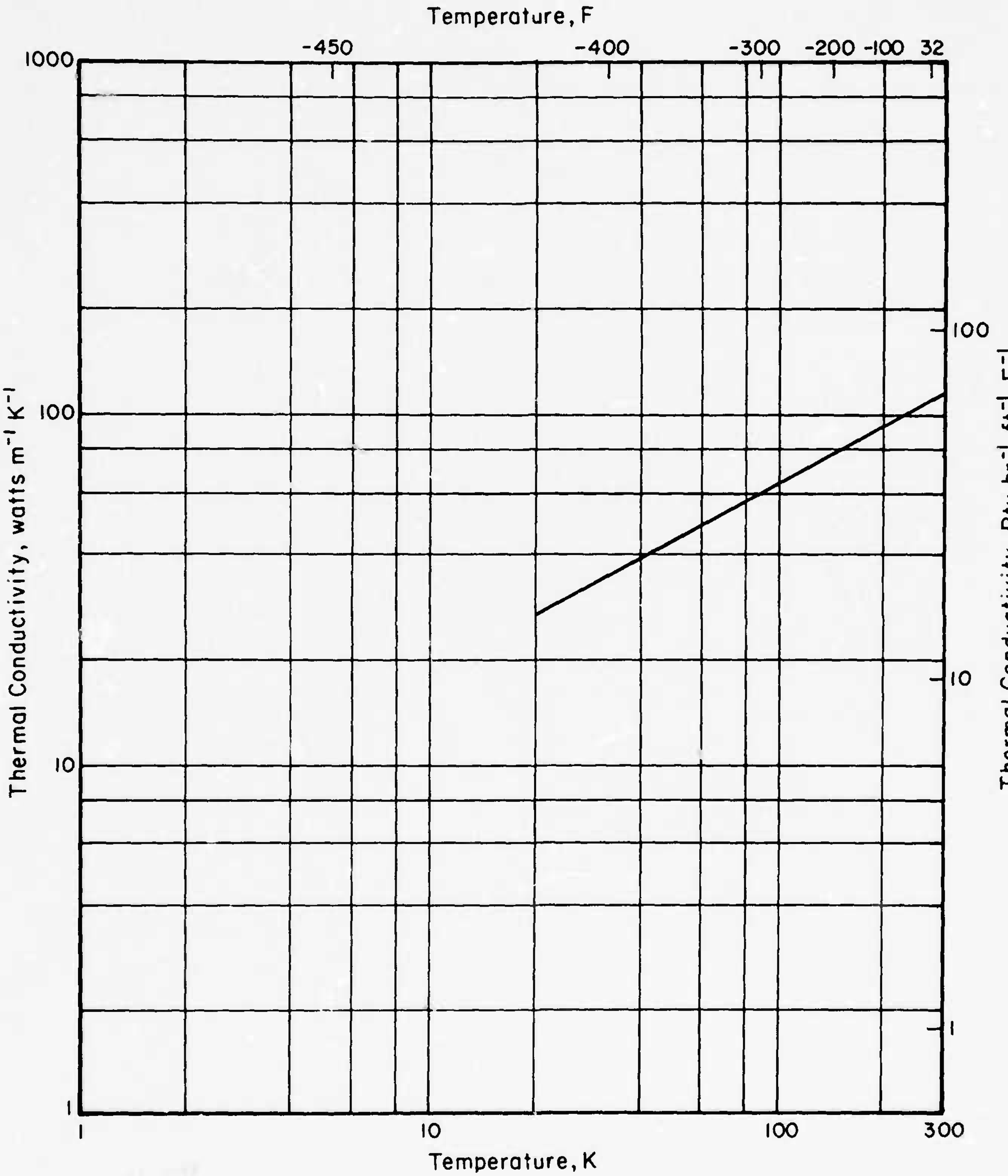

FIGURE 4.3.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5456-H343

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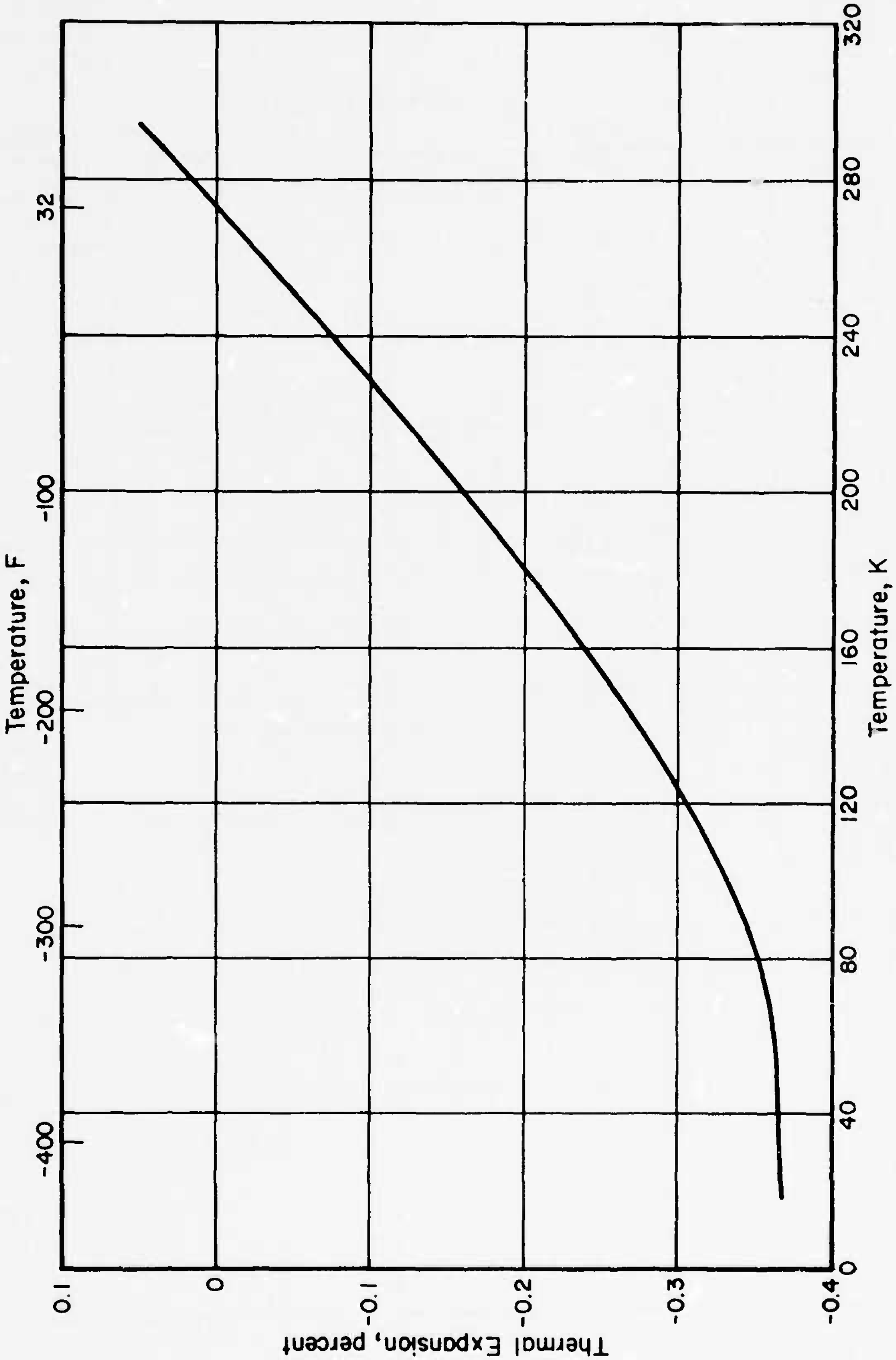

FIGURE 4.2.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5456-H343

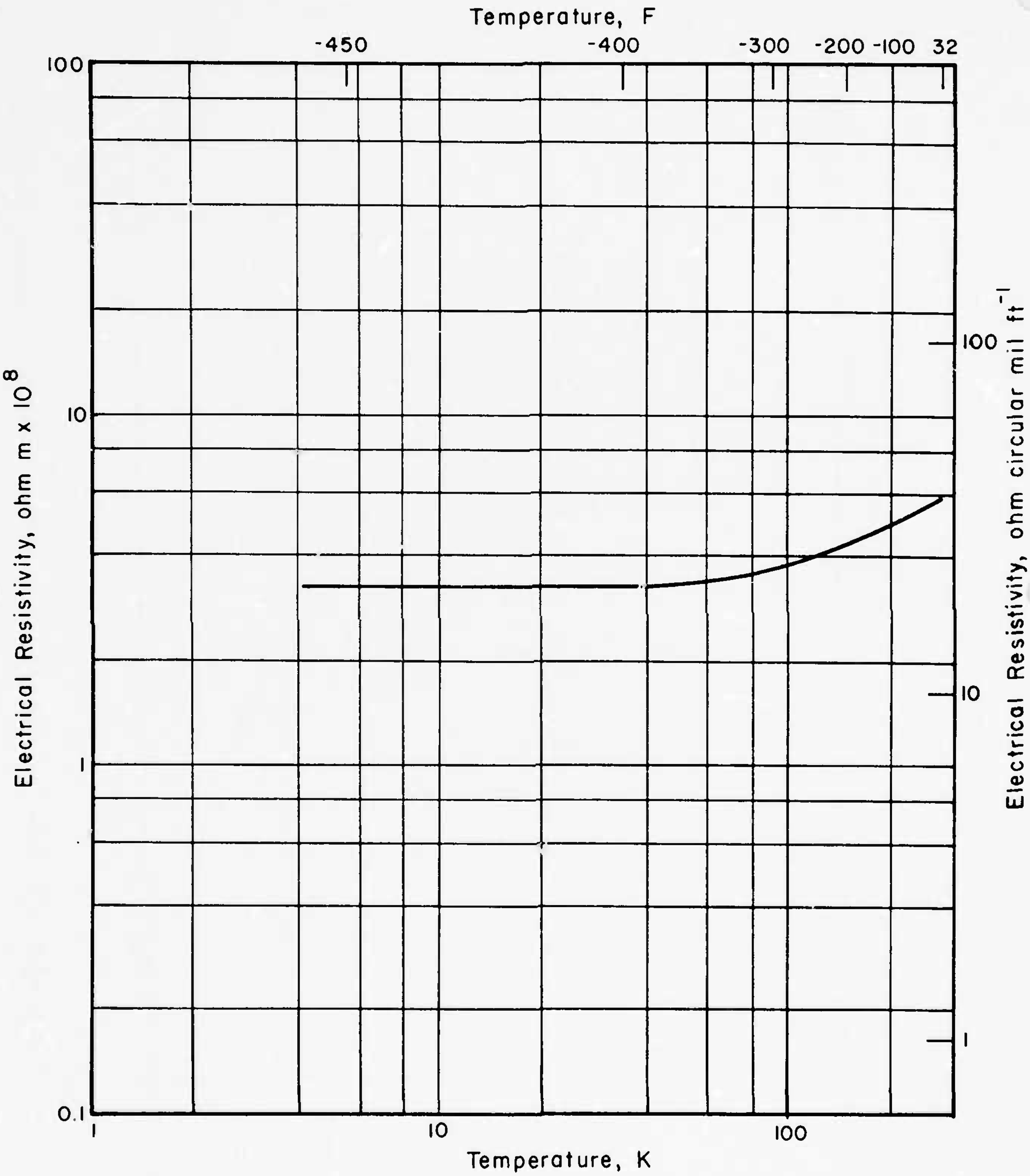

FIGURE 4.2.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5456

TABLE 4.4.1-ME0.1

Alloy Designation: 6061-T4 Aluminum Alloy

Specification: QQ-A-327
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: T4

Testing Temperature, K (F)		297	(75)	195	(-108)		77	(-320)	20	(-423)	
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	279	(40.5)	305	(44.2)		400	(58.0)	598	(86.8)	
	Min	277	(40.2)	301	(43.6)		399	(57.9)	597	(86.6)	
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	211	(30.6)	221	(32.0)		259	(37.5)	325	(47.2)	
	Min	210	(30.4)	217	(31.5)		256	(37.2)	320	(46.4)	
Std. Deviation											
Elong, percent	Avg	17.2		20.3			28.7		31.2		
	Min	17.0		20.0			27.5		31.0		
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		3	(1)	3	(1)		3	(1)	3	(1)	
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	283	(41.0)	292	(42.4)		353	(51.2)	427	(62.0)	
K_t = 6.3	Min	276	(40.1)	290	(42.1)		345	(50.0)	423	(61.8)	
No. of Spec. (No. of Heats)		2	(1)	3	(1)		3	(1)	3	(1)	
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	274	(39.7)	300	(43.5)		392	(56.9)	636	(92.3)	
	Min	272	(39.4)	299	(43.3)		390	(56.5)	635	(92.1)	
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	181	(26.3)	201	(29.1)		217	(31.5)	294	(42.6)	
	Min	180	(26.1)	200	(29.0)		211	(30.6)	290	(42.0)	
Std. Deviation											
Elong, percent	Avg	17.3		21.0			29.0		34.3		
	Min	17.0		20.0			28.0		34.0		
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		2	(1)	2	(1)		2	(1)	2	(1)	
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	271	(39.3)	288	(41.8)		352	(51.1)	432	(62.6)	
K_t = 6.3	Min	265	(38.4)	284	(41.2)		348	(50.5)	427	(62.0)	
No. of Spec. (No. of Heats)		3	(1)	2	(1)		2	(1)	2	(1)	
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

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References: 40988

TABLE 4.4.1-ME0.2

Alloy Designation:	6061-T4 Aluminum Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T4

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	282 (40.9)			419 (60.7)		
	Min	265 (38.4)			394 (57.1)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	159 (23.0)			209 (30.3)		
	Min	146 (21.2)			192 (27.8)		
Std. Deviation							
Elong, percent	Avg	21.3			33.8		
	Min	17			25		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	297 (43.1)			414 (60.0)		
K_t = 3	Min	288 (41.7)			403 (58.5)		
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	279 (40.5)			403 (58.4)		
	Min	265 (38.4)			396 (57.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	155 (22.5)			197 (28.5)		
	Min	146 (21.2)			194 (28.1)		
Std. Deviation							
Elong, percent	Avg	23.8			34.3		
	Min	23			32		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	293 (42.5)			392 (56.8)		
K_t = 3	Min	285 (41.4)			350 (50.7)		
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52862

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TABLE 4.4.1-ME3

Alloy Designation:	6061-T6 Aluminum Alloy
Specification:	AMS-4027G, QQ-A-250/11D
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.318 (0.040 to 0.125)
Condition:	T6

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 150 rms, Rockwell B 39						
S_N at 10^5 cycles, MN/m^2(ksi)	172 (25)		255 (37)	275 (40)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.60		0.66	0.58		
S_N at 10^6 cycles, MN/m^2(ksi)	158 (23)		220 (32)	234 (34)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.55		0.57	0.49		
S_N at 10^7 cycles, MN/m^2(ksi)	152 (22)		214 (31)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.52		0.55			
Fatigue, Flexural Loading, Surface Finish 20 rms, Rockwell B 44						
S_N at 10^5 cycles, MN/m^2(ksi)	186 (27)		255 (37)	290 (42)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.63		0.65	0.60		
S_N at 10^6 cycles, MN/m^2(ksi)	165 (24)		228 (33)	228 (33)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.57		0.58	0.47		
S_N at 10^7 cycles, MN/m^2(ksi)	152 (22)		200 (29)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^7 cycles	0.51		0.51			

References: 83417

TABLE 4.4.1-ME3.1

Alloy Designation:	6061 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-MIG welded, 4043 Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	6061-T4 Sheet, welded and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	248 (35.9)			375 (54.4)		
	Min	240 (34.8)			367 (53.2)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	138 (20.0)			179 (25.9)		
	Min	128 (18.5)			167 (24.2)		
Std. Deviation							
Elong, percent	Avg	12.3			19.4		
	Min	10			18		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			5 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	176 (25.5)			224 (54.5)		
K_t = 3	Min	161 (23.4)			195 (29.3)		
No. of Spec. (No. of Heats)		4 (2)			3 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	236 (34.2)			376 (54.5)		
	Min	225 (32.6)			369 (53.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	136 (19.7)			197 (28.5)		
	Min	129 (18.7)			181 (26.2)		
Std. Deviation							
Elong, percent	Avg	11.5			16		
	Min	8			5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			5 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	189 (27.4)			223 (32.3)		
K_t = 3	Min	179 (26.0)			213 (30.9)		
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52862

TABLE 4.4.1-ME3.2

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:
Form: Sheet-MIG welded, 4043 Alloy filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: 6061-T4 Sheet, welded, aged to T6, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	304 (44.1)			397 (57.6)		
	Min	274 (39.7)			386 (56.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	277 (40.2)			326 (47.3)		
	Min	254 (36.8)			316 (45.9)		
Std. Deviation							
Elong, percent	Avg	4.5			5.2		
	Min	3			2		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)			7 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	249 (36.1)			284 (41.2)		
K_t = 3	Min	225 (32.7)			263 (38.1)		
No. of Spec. (No. of Heats)		5 (2)			6 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	301 (43.6)			399 (57.9)		
	Min	283 (41.0)			349 (50.6)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	262 (38.0)			332 (48.2)		
	Min	208 (30.1)			348 (50.5)		
Std. Deviation							
Elong, percent	Avg	4.4			5.9		
	Min	3			1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (2)			8 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	250 (36.2)			290 (42.0)		
K_t = 3	Min	232 (33.6)			259 (37.5)		
No. of Spec. (No. of Heats)		5 (2)			5 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52862

TABLE 4.4.1-ME3.3

Alloy Designation:	6061 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-MIG welded, 4043 Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	6061-T6 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	222 (32.2)			327 (47.4)	452 (65.5)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	160 (23.2)			199 (28.8)	221 (32.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	5.3			10.5	10.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	235 (34.1)			262 (38.0)	288 (41.8)	
K_t = 30.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	216 (31.3)			325 (47.2)	413 (59.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	171 (24.8)			196 (28.4)	413 (59.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	5.0			8.5	6.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90076

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TABLE 4.4.1-ME3.4

Alloy Designation:	**6061 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-TIG welded, 4043 Alloy filler**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**6061-T6 Sheet, welded and tested**

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	203 (29.4)			308 (44.6)	412 (59.7)	
	Min					410 (59.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	6* (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	201 (29.2)			310 (44.9)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 42002

* 6 specimens tested at 20 K (-423 F) each had longitudinal grain orientation on one side of the weld, transverse on the other.

TABLE 4.4.1-ME4

Alloy Designation:	6061-T6 Aluminum Alloy
Specification:	AMS-4027G, QQ-A-250/11D
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	T6

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	310 (45.0)			496 (72.0)		
	Min	309 (44.8)			494 (71.6)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	288 (41.9)			362 (52.5)		
	Min	288 (41.8)			358 (52.0)		
Std. Deviation							
Elong, percent	Avg	11.5			23.8		
	Min	11			22.5		
RA, percent	Avg	33.6			33.6		
	Min	32.4			33.1		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	303 (44.0)			421 (61.0)		
K_t = 6.3	Min	292 (42.3)			414 (60.0)		
No. of Spec. (No. of Heats)		4 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66080

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TABLE 4.4.1-ME6.1

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 4043 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 6061-T6 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	214 (31.0)	239 (34.6)		303 (44.0)		339 (49.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	144 (20.9)	163 (23.6)		178 (25.8)		259 (37.6)
	Min						
Std. Deviation							
Elong, percent	Avg	6.0	6.0		5.5		4.5
	Min						
RA, percent	Avg	19	19		12		9
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	234 (34.0)	266 (38.6)		273 (39.6)		275 (39.9)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 90072

TABLE 4.4.1-ME6.2

Alloy Designation:	6061 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 4043 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	6061-T6 Plate, welded, heat treated to T6, and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	295 (43.3)	330 (47.8)		395 (57.3)		452 (65.6)
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	248 (35.9)	264 (38.3)		292 (42.3)		309 (44.8)
	Min						
Std Deviation							
Elong, percent	Avg	11.0	21.5		16.5		15.0
	Min						
RA, percent	Avg	44	38		12		16
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	396 (57.5)	424 (61.5)		447 (64.8)		463 (67.2)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

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TABLE 4.4.1-ME6.3

Alloy Designation:	6061 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5356 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	6061-T6 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	225 (32.7)	256 (37.1)		324 (47.0)		398 (57.7)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	156 (22.6)	170 (24.7)		188 (27.3)		243 (35.3)
	Min						
Std. Deviation							
Elong, percent	Avg	8.0	9.0		13.5		13.5
	Min						
RA, percent	Avg	31	36		39		24
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	323 (46.9)	345 (50.1)		373 (54.1)		367 (53.3)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.4.1-ME6.4

Alloy Designation:	6061 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5356 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	6061-T6 Plate, welded, heat treated to T6, and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	279 (40.5)	320 (46.4)		394 (57.1)		476 (69.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	202 (29.3)	242 (35.1)		234 (33.9)		307 (44.5)
	Min						
Std. Deviation							
Elong, percent	Avg	9.5	12.0		20.0		19.0
	Min						
RA, percent	Avg	33	44		29		24
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg		399 (57.8)		458 (66.4)		419 (60.8)
K_t = 16	Min						
No. of Spec. (No. of Heats)			1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

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TABLE 4.4.1-ME9

Alloy Designation:	6061-T6 Aluminum Alloy
Specification:	QQ-A-325B
Form:	Bar
Diameter:	Up to 2.54 cm (1.000 in.)
Condition:	T6

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	523 (46.8)	344 (49.9)	407 (59)	429 (61.5)	522 (75.7)	572 (83.0)
	Min	305 (44.2)	332 (48.1)		412 (59.7)	520 (75.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	288 (41.8)	294 (42.6)	338 (49.0)	339 (49.2)	370 (53.7)	400 (58.0)
	Min	270 (39.2)	277 (40.2)		310 (45.0)	356 (51.7)	
Std. Deviation							
Elong, percent	Avg	17.6	19.6	19.0	23.8	29.9	22.0
	Min	15.3	16.5		19.0	29.0	
RA, percent	Avg	53.8	52.5	45.5	47.2	44.6	39.2
	Min	50	50		41.6	43.4	
No. of Spec. (No. of Heats)		8 (4)	5 (3)	(1)	8 (4)	5 (2)	(1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

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References: 47311, 47334, 54986, 83417, 90203

TABLE 4.4.1-ME10

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: QQ-A-325B
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: T6

Testing Temperature, K (F)		297	(75)	195	(-108)	122	(-240)	77	(-320)			10	(-441)
Compression, Longitudinal													
CYS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Ec, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Compression, Transverse													
CYS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Ec, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Shear[a]													
SUS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
G, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Impact, Charpy V													
Long., J(ft-lb)	Avg	17.1	(12.6)	17.6	(13.0)	17.5	(12.9)	17.2	(12.7)			17	(12.6)
	Min												
No. of Spec. (No. of Heats)													
Trans., J(ft-lb)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Fracture Toughness[b]													
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg												
	Min												
Orientation —													
No. of Spec. (No. of Heats)													
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg												
(From PTSC spec.)(—)	Min												
No. of Spec. (No. of Heats)													

References: 47311, 47334

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 4.4.1-ME11

Alloy Designation:	6061-T6 Aluminum Alloy
Specification:	QQ-A-325 B
Form:	Bar
Diameter:	Up to 2.54 cm (1.000 in.)
Condition:	T6

Testing Temperature, K (F)	297 (75)		77 (-320)			
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	193 (28)		331 (48)			
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^6 cycles	0.58		0.76			
S_N at 10^7 cycles, MN/m^2(ksi)	145 (21)		296 (43)			
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.44		0.68			
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 83417

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TABLE 4.4.1-ME11.1

Alloy Designation:	6061-0 Aluminum Alloy
Specification:	
Form:	Rod
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	123 (17.8)	138 (20.0)		228 (33.1)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	43 (6.2)	50 (7.2)		58 (8.4)		
	Min						
Std. Deviation							
Elong, percent	Avg		40.5		48.5		
	Min						
RA, percent	Avg	72	74		67		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90203

TABLE 4.4.1-ME11.2

Alloy Designation: 6061-T4 Aluminum Alloy

Specification:
Form: Rod
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: T4

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	278 (40.3)	304 (44.1)		399 (57.9)		
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	150 (21.8)	160 (23.2)		203 (29.4)		
	Min						
Std Deviation							
Elong, percent	Avg		32.5		36.6		
	Min						
RA, percent	Avg	57	54		41		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90203

TABLE 4.4.1-ME11.3

Alloy Designation: 6061-T91 Aluminum Alloy

Specification:
Form: Rod
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: T91

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	392 (56.8)	431 (62.5)		509 (73.8)		
	Min	381 (55.2)	414 (60.0)		490 (71.1)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	387 (56.1)	415 (60.2)		472 (68.4)		
	Min	376 (54.6)	398 (57.7)		448 (65.0)		
Std. Deviation							
Elong, percent	Avg		4.4		15.3		
	Min		4.2		15.3		
RA, percent	Avg	38.5	39.5		38		
	Min	37	37		37		
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90203

TABLE 4.4.1-ME12

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: AMS-4127
Form: Forgings, rolled rings and other shapes
Thickness, cm (in.):
Condition: T6

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	310	(44.9)	348	(50.6)	434	(63.0)	499	(72.4)		
	Min	285	(41.4)	323	(46.9)	415	(60.2)	440	(63.8)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	275	(39.9)	301	(43.7)	326	(47.3)	379	(54.9)		
	Min	255	(37.0)	295	(42.8)	305	(44.2)	352	(51.1)		
Std. Deviation											
Elong, percent	Avg	19.8		19.8		24.5		24.9			
	Min	19.0		17.0		24.0		23.0			
RA, percent	Avg	51.5		50.8		41.5		38.6			
	Min	34.9		38.0		34.3		32.8			
No. of Spec. (No. of Heats)		6	(2)	6	(2)	6	(2)	6	(2)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	436	(63.3)	463	(67.2)	542	(78.6)	562	(81.5)		
K_t = 6 to 8	Min	431	(62.5)	451	(65.4)	536	(77.8)	529	(76.7)		
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
Elong, percent	Avg										
	Min										
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)											
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 35611, 66080

TABLE 4.5.1-ME3

Alloy Designation:	7039-T6 Aluminum Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	T6

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading (R = -1)						
S_N at 10^6 cycles, MN/m^2(ksi)	138 (20)		214 (31)	276 (40)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.31		0.40	0.43		
S_N at 10^6 cycles, MN/m^2(ksi)	48.2 (7)		48.2 (7)	62.1 (9)		
Loading frequency Hz						
with R = -1 and K_t = 6.3						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m^2(ksi)	37.9 (5.5)		73.7 (10.7)	79.3 (11.5)		
Loading frequency Hz						
with R = -1 and K_t = 8						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Fatigue, Axial Loading (R = 0.01)						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	228 (33)		331 (48)	441 (64)		
Loading frequency Hz						
with R = 0.01 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.51		0.61	0.67		
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 58024, 61996

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TABLE 4.5.1-ME3.1

Alloy Designation:	**7039 Aluminum Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-MIG welded, 5183 Alloy filler**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**7039-T6 Sheet; welded natural aged 15-30 days, and tested**

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	367 (53.2)			391 (56.7)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	240 (34.8)			299 (43.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	7.0			3.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	405 (58.7)			434 (63.0)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME3.2

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-"Fusion" welded, filler not specified
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	7039-T6 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	383 (55.5)	388 (56.3)		405 (58.8)	354 (51.4)	
	Min	372 (53.9)	378 (54.8)		361 (52.9)	303 (43.9)	
Std Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	9.1	8.4		7.2	0.9	
	Min	7.5	4.0		6.0	0.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	379 (54.9)	387 (56.2)		404 (58.6)	392 (56.9)	
	Min	375 (54.4)	371 (53.8)		390 (56.6)	381 (55.3)	
Std Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	9.4	9.4		5.6	0.7	
	Min	8.0	7.0		6.0	0.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 56261

TABLE 4.5.1-ME4

Alloy Designation: 7039-T61 Aluminum Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)
Condition: T61

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	400 (58.0)		494 (71.7)			
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg	326 (47.3)		366 (53.1)			
	Min						
Std. Deviation							
Elong, percent	Avg	14.5		18.1			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	409 (59.3)		532 (77.2)			
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg	328 (47.6)		384 (55.7)			
	Min						
Std. Deviation							
Elong, percent	Avg	12.9		15.5			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90075

TABLE 4.5.1-ME4.1

Alloy Designation:	*7039 Aluminum Alloy (Weld Metal)*
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	0.320 to 0.634 (0.126 to 0.249)
Condition:	7039-T61 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	317 (46.0)			422 (61.2)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	177 (25.6)			209 (30.3)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.6			14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90075

TABLE 4.5.1-ME4.2

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	0.320 to 0.634 (0.126 to 0.249)
Condition:	7039-T61 Sheet, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	353 (51.2)			445 (64.6)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	210 (30.4)			254 (36.9)		
	Min						
Std. Deviation							
Elong, percent	Avg	<11.4			<14		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90075

TABLE 4.5.1-ME5

Alloy Designation:	7039-T6, T61 Aluminum Alloy
Specification:	AMS-4024A, MIL-A-8877
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	T6, T61

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)	
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	429	(62.3)	478	(69.3)	501	(72.7)	549	(79.7)	654	(94.8)	
	Min	402	(58.3)					523	(75.9)			
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	372	(53.9)	427	(62.0)	449	(65.1)	438	(63.7)	504	(73.1)	
	Min	328	(47.5)					378	(54.8)			
Std. Deviation												
Elong, percent	Avg	16.3		12.7		12.7		18.4		15.7		
	Min	12.5						14.1				
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		7	(3)		(1)		(1)	7	(3)		(1)	
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg	503	(72.9)					561	(81.4)			
K_t = 6.3	Min											
No. of Spec. (No. of Heats)		3	(1)					3	(1)			
NTS, MN/m^2 (ksi)	Avg	483	(70.0)	510	(73.9)	521	(75.6)	557	(80.8)	560	(81.2)	
K_t = 10	Min											
No. of Spec. (No. of Heats)			(1)		(1)		(1)		(1)		(1)	
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg	434	(63.0)	479	(69.5)	514	(74.5)	566	(82.1)	651	(94.4)	
	Min	401	(58.2)					539	(78.2)			
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	369	(53.5)	426	(61.8)	450	(65.2)	439	(63.7)	518	(75.2)	
	Min	325	(47.2)					385	(55.9)			
Std. Deviation												
Elong, percent	Avg	14.5		11.0		12.1		15.4		11.7		
	Min	10.5						11.3				
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		7	(3)		(1)		(1)	7	(3)		(1)	
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg	504	(73.1)					539	(78.2)			
K_t = 6.3	Min											
No. of Spec. (No. of Heats)		3	(1)					3	(1)			
NTS, MN/m^2 (ksi)	Avg	483	(70.1)	507	(73.5)	516	(74.9)	506	(73.4)	494	(71.6)	
K_t = 10	Min											
No. of Spec. (No. of Heats)			(1)		(1)		(1)		(1)		(1)	

References: 90082, 90107

TABLE 4.5.1-ME5.1

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5083 Alloy filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	352 (51.1)			433 (62.8)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	203 (29.4)			254 (36.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	14.0			14.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	399 (57.9)			411 (59.6)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME5.2

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-TIG welded, 5039 Alloy filler
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	361 (52.4)			380 (55.1)		
	Min	348 (50.5)			362 (52.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	220 (31.9)			266 (38.6)		
	Min	214 (31.0)			260 (37.7)		
Std. Deviation							
Elong, percent	Avg	10.2			5.0		
	Min	9.3			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)			8 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	345 (50.1)			348 (50.4)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		8 (2)			8 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME5.3

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, no filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	368 (53.4)			420 (60.9)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	224 (32.6)			268 (38.9)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.5			7.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	355 (51.5)			354 (51.4)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME5.4

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5039 Alloy filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	7039-T64 Plate, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	359 (52)			448 (65)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	224 (32.5)			279 (40.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.0			6.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 67769

TABLE 4.5.1-ME6

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T6, T61

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	437	(63.4)	486	(70.5)	507	(73.5)	589	(85.4)	675	(97.9)
	Min	407	(59.1)	445	(64.6)	467	(67.7)	525	(76.2)	623	(90.4)
Std. Deviation		29.3	(4.25)					18.6	(2.70)	34.7	(5.04)
TYS, MN/m^2 (ksi)	Avg	396	(57.4)	429	(62.2)	446	(64.7)	477	(69.2)	516	(74.9)
	Min	352	(51.0)	381	(55.3)	399	(57.9)	432	(62.7)	466	(67.6)
Std. Deviation		31.7	(4.60)					33.8	(4.91)		
Elong, percent	Avg	13.5		14.0		14.5		16.6		14.0	
	Min	11.8		13.3		14.2		15.7		12.0	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		15	(5)	3	(1)	3	(1)	15	(5)	9	(3)
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	634	(91.9)					645	(93.5)		
K_t = 6.3	Min										
No. of Spec. (No. of Heats)			(2)						(2)		
NTS, MN/m^2 (ksi)	Avg	530	(76.8)	553	(80.2)	563	(81.7)	561	(81.4)	553	(80.2)
K_t = 10	Min	486	(70.5)	512	(74.2)	532	(77.2)	550	(79.7)	534	(77.5)
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	445	(64.6)	484	(70.2)	510	(73.9)	578	(83.9)	658	(95.5)
	Min	405	(58.7)	442	(64.1)	467	(67.7)	528	(76.6)	611	(88.6)
Std. Deviation		28.7	(4.17)					21.1	(3.06)	19.7	(2.86)
TYS, MN/m^2 (ksi)	Avg	384	(55.7)	416	(60.3)	432	(62.6)	464	(67.3)	491	(71.2)
	Min	346	(50.2)	377	(54.7)	394	(57.1)	423	(61.4)	441	(63.9)
Std. Deviation		31.4	(4.55)					37.4	(5.43)	42.7	(6.20)
Elong, percent	Avg	13.1		12.6		12.8		13.6		11.8	
	Min	11.8		12.0		10.7		10.0		8.0	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		15	(5)	3	(1)	3	(1)	15	(5)	9	(3)
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	621	(90.0)					607	(88.0)		
K_t - 6.3	Min	787	(85.2)					594	(86.1)		
No. of Spec. (No. of Heats)		6	(2)					6	(2)		
NTS, MN/m^2 (ksi)	Avg	510	(74.0)	525	(76.2)	534	(77.4)	520	(75.4)	498	(72.3)
K_t = 10	Min	468	(67.9)	491	(71.2)	512	(74.2)	516	(74.8)	488	(70.8)
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)

References: 90082, 90084, 90107

TABLE 4.5.1-ME6.1

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:	
Form:	Plate-MIG welded, 5039 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	356 (51.7)			446 (64.7)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	223 (32.3)			279 (40.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.2			6.7		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	413 (59.9)			439 (63.6)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.2

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	294 (42.6)			419 (60.8)		
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	169 (24.5)			205 (29.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.8			10.2		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	355 (51.5)			406 (58.9)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.3

Alloy Designation:	7039 Aluminum Alloy
Specification:	
Form:	Plate-TIG welded, 5039 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	347 (50.3)			441 (64.0)		
	Min	343 (49.8)			432 (62.6)		
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	217 (31.5)			266 (38.6)		
	Min	215 (31.2)			263 (38.2)		
Std Deviation							
Elong, percent	Avg	11.1			6.7		
	Min	10.1			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)			8 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	336 (48.7)			328 (47.6)		
K_t = 6.3	Min	334 (48.5)			321 (46.6)		
No. of Spec. (No. of Heats)		8 (2)			8 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.4

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, 5183 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	342 (49.6)			441 (64.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	200 (29.0)			250 (36.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	12.0			12.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	319 (46.2)			328 (47.6)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.5

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-TIG welded, no filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	370 (53.7)			443 (64.2)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	237 (34.4)			290 (42.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	11.2			9.1		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	359 (52.0)			365 (52.9)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.6

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate, MIG welded, 5039 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T61 Plate, welded, natural aged 27 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	357 (51.8)			402 (58.3)	376 (54.5)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	214 (31.1)			249 (36.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.3			9.3	(2.2	
	Min						
RA, percent	Avg	22.7			12.3	3.5	
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	359 (52.1)			374 (54.2)	327 (47.9)	
K_t = 15	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.7

Alloy Designation: 7039-T6151 Aluminum Alloy

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T6151

Testing Temperature, K (F)		297 (75)	144 (-200)	116 (-250)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	405 (58.8)	471 (68.3)	498 (72.2)	550 (79.8)		649 (94.2)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	334 (48.5)	364 (52.8)	380 (55.1)	401 (58.2)		476 (69.0)
	Min						
Std. Deviation							
Elong, percent	Avg	14.9	15.1	15.7	16.3		15.5
	Min						
RA, percent	Avg	38.1	33.0	31.4	28.1		22
	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	525 (76.1)	562 (81.5)	576 (83.5)	587 (85.2)		614 (89.1)
K_t = 15-16	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	399 (57.8)	463 (67.1)	490 (71.1)	532 (77.2)		626 (90.8)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	325 (47.2)	360 (52.2)	371 (53.8)	396 (57.5)		455 (66.0)
	Min						
Std. Deviation							
Elong, percent	Avg	14.1	14.3	14.8	15.7		12.5
	Min						
RA, percent	Avg	34.6	29.9	28.3	26.5		15
	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	518 (75.1)	554 (80.4)	562 (81.5)	564 (81.8)		586 (85.0)
K_t = 15-16	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90070, 90187

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TABLE 4.5.1-ME6.8

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5039 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T6151 Plate, welded and tested

Testing Temperature, K (F)		297	(75)	144	(-200)	114	(-250)	77	(-320)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	357	(51.8)	385	(55.8)	414	(60.1)	422	(61.2)		
	Min										
Std Deviation											
TYS, MN/m^2 (ksi)	Avg	236	(34.3)	259	(37.6)	272	(39.4)	279	(40.5)		
	Min										
Std Deviation											
Elong, percent	Avg	10.0		9.3		11.9		5.7			
	Min										
RA, percent	Avg			18.8		14.7		12.7			
	Min										
No. of Spec. (No. of Heats)		6	(1)	6	(1)	6	(1)	6	(1)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	406	(58.9)	431	(62.5)	422	(61.2)	412	(59.7)		
K_t = 15	Min										
No. of Spec. (No. of Heats)		6	(1)	6	(1)	6	(1)	6	(1)		
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg										
	Min										
Std Deviation											
TYS, MN/m^2 (ksi)	Avg										
	Min										
Std Deviation											
Elong, percent	Avg										
	Min										
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)											
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 90187

TABLE 4.5.1-ME6.9

Alloy Designation:	7039-T6151 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T6351

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	463 (67.2)	520 (75.4)		610 (88.4)		711 (103.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	390 (56.5)	428 (62.1)		467 (67.8)		527 (76.4)
	Min						
Std. Deviation							
Elong, percent	Avg	14.5	14.5		17.0		17.5
	Min						
RA, percent	Avg	32	23		20		19
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	611 (88.6)	634 (91.9)		589 (85.9)		617 (89.5)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	459 (66.5)	502 (72.8)		601 (87.1)		699 (101.4)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	390 (56.6)	423 (61.4)		476 (69.0)		536 (77.7)
	Min						
Std. Deviation							
Elong, percent	Avg	13.0	12.5		13.5		13.0
	Min						
RA, percent	Avg	33	23		19		15
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	607 (88.0)	584 (84.7)		518 (75.1)		556 (80.6)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90070

TABLE 4.5.1-ME6.10

Alloy Designation:	7039 Aluminum Alloy (Weld Metal)
Specification:	
Form:	Plate-MIG welded, 5039 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	7039-T64 Plate, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	359 (52)			448 (65)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	224 (32.5)			279 (40.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.0			6.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 67769

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TABLE 4.5.1-ME8.1

Alloy Designation:	7039-T64 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	T64

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	448 (65.0)			586 (85.0)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	400 (58.0)			490 (71.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	14			17		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	676 (98)			690 (100)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 67769

TABLE 4.5.2-ME2.1

Alloy Designation:	7005-T6351 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	T6351

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	392 (56.8)	451 (65.4)		538 (78.0)		606 (87.9)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	341 (49.4)	363 (52.7)		409 (59.3)		441 (63.9)
	Min						
Std. Deviation							
Elong, percent	Avg	18.0	16.5		18.0		16.5
	Min						
RA, percent	Avg	50	41		34		29
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	561 (81.3)	610 (88.4)		678 (98.3)		689 (99.9)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	378 (54.8)	442 (64.1)		517 (75.0)		583 (84.6)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	329 (47.7)	368 (53.4)		402 (58.3)		421 (61.1)
	Min						
Std. Deviation							
Elong, percent	Avg	17.5	16.2		17.8		18.0
	Min						
RA, percent	Avg	48	42		32		31
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	561 (81.4)	610 (88.4)		663 (96.2)		685 (99.4)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90070

TABLE 4.5.2-ME2.2

Alloy Designation:	7005-T6351 Aluminum Alloy
Specification:	
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	T6351

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	363 (52.6)	423 (61.4)		486 (70.5)		590 (85.6)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	317 (46.0)	351 (50.9)		370 (53.7)		420 (60.9)
	Min						
Std. Deviation							
Elong, percent	Avg	19.8	18.0		19.0		19.5
	Min						
RA, percent	Avg	52	44		34		25
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	546 (79.2)	596 (86.4)		643 (93.2)		652 (94.6)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	367 (53.3)	427 (61.9)		502 (72.8)		595 (86.3)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	320 (46.4)	353 (51.2)		394 (57.1)		432 (62.7)
	Min						
Std. Deviation							
Elong, percent	Avg	18.0	14.8		16.5		16.5
	Min						
RA, percent	Avg	44	33		25		20
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	547 (79.4)	596 (86.4)		620 (89.9)		632 (91.6)
K_t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90070

INDEX TO MATERIAL CODES FOR SECTION 5.0

COPPER AND COPPER ALLOYS

MATERIALS	MATERIAL CODE
COPPER, 99.96+	5.1.1
ELECTROLYTIC TOUGH PITCH Cu	5.1.2
OFHC COPPER	5.1.3
COPPER, PHOSPHORIZED	5.1.4
80Cu-20Zn	5.2.1
70Cu-30Zn	5.2.2
65Cu-35Zn	5.2.3
90Cu-10Zn	5.2.4
COPPER-NICKEL ALLOYS	5.3.0
90Cu-10Ni	5.3.1
80Cu-20Ni	5.3.2
70Cu-30Ni	5.3.3
Cu-Be	5.4.2
95Cu-5Sn	5.5.1
92Cu-8Sn	5.5.2
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COPPER-ZIRCONIUM ALLOYS	5.6.1
COPPER-CHROMIUM-CADMIUM ALLOYS	5.7.1
COPPER-ALUMINUM ALLOYS	5.9.1

TABLE 5.1.1-TR1

Alloy Designation: Copper

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature, K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity(1)						
RRR-3000 Watts m^{-1} K^{-1}	401	483	1330	10700	27200	18300
Btu hr^{-1} ft^{-1} F^{-1}	(232)	(279)	(769)	(6190)	(15700)	(10600)
RRR-1000 Watts m^{-1} K^{-1}	401	482	1250	8370	12500	6230
Btu hr^{-1} ft^{-1} F^{-1}	(232)	(279)	(723)	(4840)	(7230)	(3600)
RRR-300 Watts m^{-1} K^{-1}	400	479	1130	5010	4350	1880
Btu hr^{-1} ft^{-1} F^{-1}	(231)	(277)	(653)	(2900)	(2520)	(1090)
RRR-100 Watts m^{-1} K^{-1}	397	469	979	2380	1520	623
Btu hr^{-1} ft^{-1} F^{-1}	(230)	(271)	(566)	(1380)	(879)	(360)
RRR-30 Watts m^{-1} K^{-1}	389	438	740	834	453	183
Btu hr^{-1} ft^{-1} F^{-1}	(225)	(253)	(428)	(482)	(262)	(106)
No. of Spec.						
References: 90170, 90224						
Thermal Expansion (T_{273} to T)						
Longitudinal						
Percent	0	-0.252	-0.290	-0.293	-0.293	-0.293
No. of Spec.	5	5	5	5	3	3
References: 40911, 48571, 90208, 90336, 90458						
Specific Heat						
Joules kg^{-1} K^{-1}	375	248	95	7	0.92	0.11
Btu lb^{-1} F^{-1}	(0.0896)	(0.0593)	(0.0227)	(0.00167)	(0.000220)	(0.0000263)
No. of Spec.	5	5	4	8	6	7
References: 40911, 42219, 90223, 90247, 90249, 90339						
Electrical Resistivity(1)						
RRR-30000 Ohm m	1.55×10^{-8}	3.50×10^{-9}	5.01×10^{-10}	8.52×10^{-12}	7.32×10^{-13}	5.19×10^{-13}
Ohm circular mil ft^{-1}	(9.32)	(2.11)	(3.01×10^{-1})	(5.12×10^{-3})	(4.40×10^{-4})	(3.12×10^{-4})
RRR-10000 Ohm m	1.55×10^{-8}	3.50×10^{-9}	5.02×10^{-10}	9.55×10^{-12}	1.77×10^{-12}	1.55×10^{-12}
Ohm circular mil ft^{-1}	(9.32)	(2.11)	(3.02×10^{-1})	(5.74×10^{-3})	(1.06×10^{-3})	(9.32×10^{-4})
RRR-3000 Ohm m	1.55×10^{-8}	3.51×10^{-9}	5.05×10^{-10}	1.32×10^{-11}	5.38×10^{-12}	5.17×10^{-12}
Ohm circular mil ft^{-1}	(9.32)	(2.11)	(3.04×10^{-1})	(7.94×10^{-3})	(3.24×10^{-3})	(3.11×10^{-3})
RRR-1000 Ohm m	1.55×10^{-8}	3.52×10^{-9}	5.16×10^{-10}	2.35×10^{-11}	1.57×10^{-11}	1.55×10^{-11}
Ohm circular mil ft^{-1}	(9.32)	(2.12)	(3.10×10^{-1})	(1.41×10^{-2})	(9.44×10^{-3})	(9.32×10^{-3})
RRR-300 Ohm m	1.56×10^{-8}	3.55×10^{-9}	5.52×10^{-10}	5.98×10^{-11}	5.12×10^{-11}	5.18×10^{-11}
Ohm circular mil ft^{-1}	(9.38)	(2.14)	(3.32×10^{-1})	(3.60×10^{-2})	(3.13×10^{-2})	(3.12×10^{-2})
RRR-100 Ohm m	1.57×10^{-8}	3.66×10^{-9}	6.57×10^{-10}	1.65×10^{-10}	1.57×10^{-10}	1.57×10^{-10}
Ohm circular mil ft^{-1}	(9.44)	(2.20)	(3.95×10^{-1})	(9.92×10^{-2})	(9.44×10^{-2})	(9.44×10^{-2})
RRR-30 Ohm m	1.60×10^{-8}	4.03×10^{-9}	1.03×10^{-9}	5.42×10^{-10}	5.35×10^{-10}	5.34×10^{-10}
Ohm circular mil ft^{-1}	(9.62)	(2.42)	(6.20×10^{-1})	(3.26×10^{-1})	(3.22×10^{-1})	(3.21×10^{-1})
No. of Spec.						
References: 90111, 90125, 90178, 96886						
Magnetothermal Conductivity — H (tesla)						
RRR-1520						
Watts m^{-1} K^{-1} — 0				11700	17300	
Btu hr^{-1} ft^{-1} F^{-1}				(6765)	(10002)	
Watts m^{-1} K^{-1} — 1				5500	6500	
Btu hr^{-1} ft^{-1} F^{-1}				(3180)	(3758)	
Watts m^{-1} K^{-1} — 2					4800	
Btu hr^{-1} ft^{-1} F^{-1}					(2775)	
Watts m^{-1} K^{-1} — 4				3700	4500	
Btu hr^{-1} ft^{-1} F^{-1}				(2139)	(2602)	
Watts m^{-1} K^{-1} — 8				3100	3800	
Btu hr^{-1} ft^{-1} F^{-1}				(1792)	(2197)	
No. of Spec.				1	1	
References: 94208						

TABLE 5.1.1-TR1 (Cont.)

Alloy Designation: Copper

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature, K (F)				20 (-423)	10 (-442)	4 (-452)
Magnetoresistance(2)						
H = 1 Tesla						
RRR-30000 Ohm m				5.49×10^{-11}	3.38×10^{-11}	3.12×10^{-11}
Ohm circular mil ft^{-1}				(3.30×10^{-2})	(2.03×10^{-2})	(1.88×10^{-2})
RRR-10000 Ohm m				5.62×10^{-11}	4.07×10^{-11}	3.96×10^{-11}
Ohm circular mil ft^{-1}				(3.38×10^{-2})	(2.45×10^{-2})	(2.38×10^{-2})
RRR-3000 Ohm m				6.06×10^{-11}	5.01×10^{-11}	4.97×10^{-11}
Ohm circular mil ft^{-1}				(3.65×10^{-2})	(3.01×10^{-2})	(2.99×10^{-2})
RRR-1000 Ohm m				7.15×10^{-11}	6.34×10^{-11}	6.32×10^{-11}
Ohm circular mil ft^{-1}				(4.30×10^{-2})	(3.81×10^{-2})	(3.80×10^{-2})
RRR-300 Ohm m				1.07×10^{-10}	9.96×10^{-11}	9.94×10^{-11}
Ohm circular mil ft^{-1}				(6.44×10^{-2})	(5.99×10^{-2})	(5.98×10^{-2})
RRR-100 Ohm m				2.09×10^{-10}	2.01×10^{-10}	2.01×10^{-10}
Ohm circular mil ft^{-1}				(1.26×10^{-1})	(1.21×10^{-1})	(1.21×10^{-1})
RRR-30 Ohm m				5.80×10^{-10}	5.72×10^{-10}	$5.72 \times 10^{-[illegible]}$
Ohm circular mil ft^{-1}				(3.49×10^{-1})	(3.44×10^{-1})	(3.44×10^{-1})
H = 10 Tesla						
RRR-30000 Ohm m				3.50×10^{-10}	1.75×10^{-10}	1.54×10^{-10}
Ohm circular mil ft^{-1}				(2.11×10^{-1})	(1.05×10^{-1})	(9.26×10^{-2})
RRR-10000 Ohm m				3.59×10^{-10}	2.33×10^{-10}	2.24×10^{-10}
Ohm circular mil ft^{-1}				(2.16×10^{-1})	(1.40×10^{-1})	(1.35×10^{-1})
RRR-3000 Ohm m				3.83×10^{-10}	3.15×10^{-10}	3.12×10^{-10}
Ohm circular mil ft^{-1}				(2.30×10^{-1})	(1.89×10^{-1})	(1.88×10^{-1})
RRR-1000 Ohm m				4.30×10^{-10}	3.97×10^{-10}	3.96×10^{-10}
Ohm circular mil ft^{-1}				(2.59×10^{-1})	(2.39×10^{-1})	(2.38×10^{-1})
RRR-300 Ohm m				5.14×10^{-10}	5.01×10^{-10}	5.00×10^{-10}
Ohm circular mil ft^{-1}				(3.09×10^{-1})	$(3.0[illegible] \times 10^{-1})$	(3.01×10^{-1})
RRR-100 Ohm m				6.48×10^{-10}	6.40×10^{-10}	6.40×10^{-10}
Ohm circular mil ft^{-1}				(3.90×10^{-1})	(3.85×10^{-1})	(3.85×10^{-1})
RRR-30 Ohm m				1.03×10^{-9}	1.02×10^{-9}	1.02×10^{-9}
Ohm circular mil ft^{-1}				(6.20×10^{-1})	(6.14×10^{-1})	(6.14×10^{-1})
No. of Spec.				8	8	8
References: 96887						

(1) Interpolated from numerous data using theoretical correlations.

(2) The electrical magnetoresistance of pure copper and of OFHC copper can be represented on a universal curve, called a Kohler plot, which is shown in Figure 5.1.1-MR1. The curve can be represented by the equation:

$$\log_e\left(\frac{\rho(H,T)-\rho(O,T)}{\rho(O,T)}\right) = a_0 + a_1\log_e\left[H\cdot\frac{\rho(0,273\text{ K})}{\rho(O,T)}\right] + a_2\left\{\log_e\left[H\cdot\frac{\rho(0,273\text{ K})}{\rho(O,T)}\right]\right\}^2$$

Where $\rho(H,T)$ = electrical resistivity at magnetic field H, and at temperature T. If the field H is given in tesla, then the constants have the values:

$a_0 = 7.008$; $a_1 = 1.383$; $a_2 = -0.0298$.

The plot is valid over the temperature range 4-35 K, and over the magnetic field range 0-10 tesla.

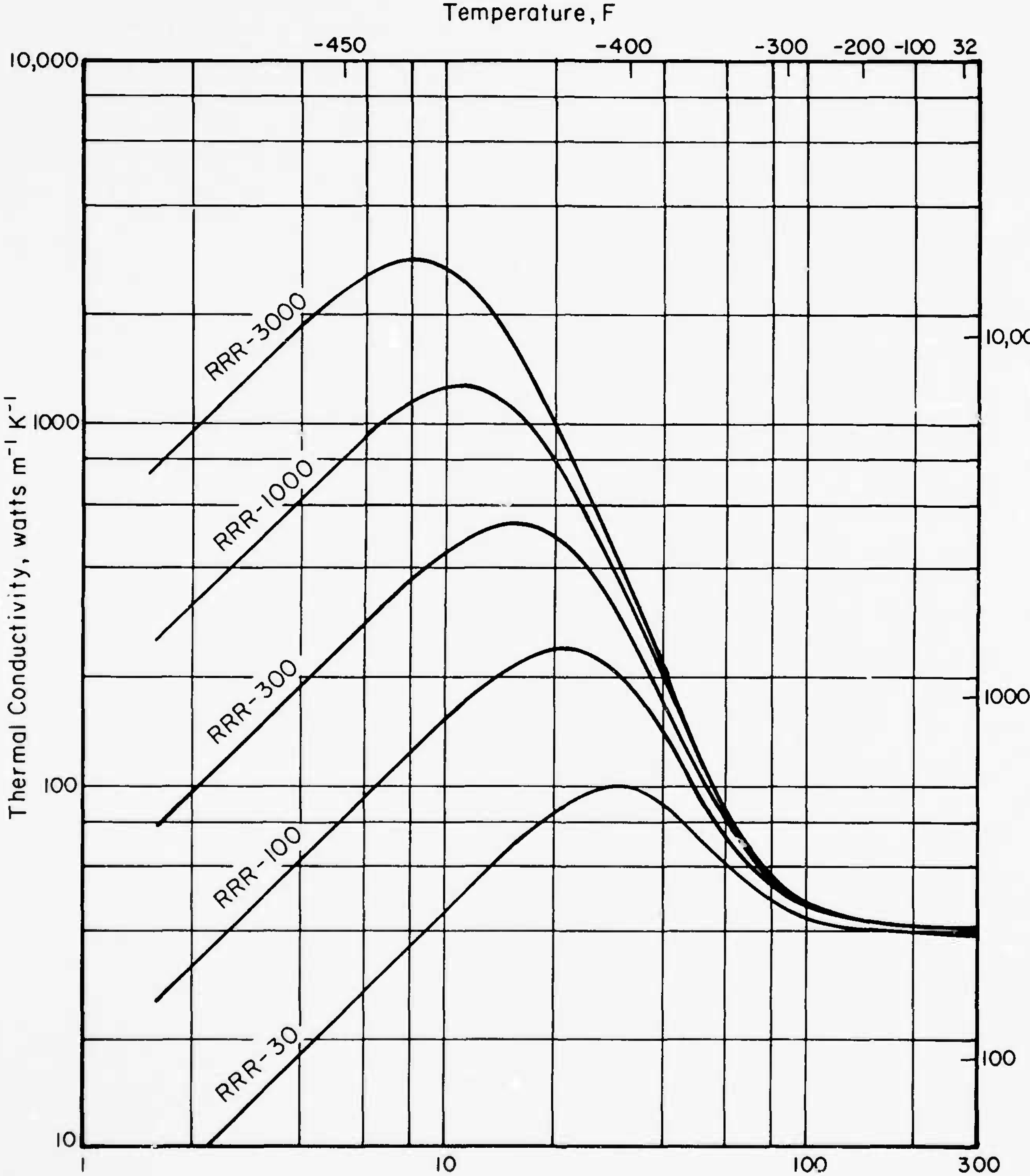

FIGURE 5.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATUE FOR COPPER

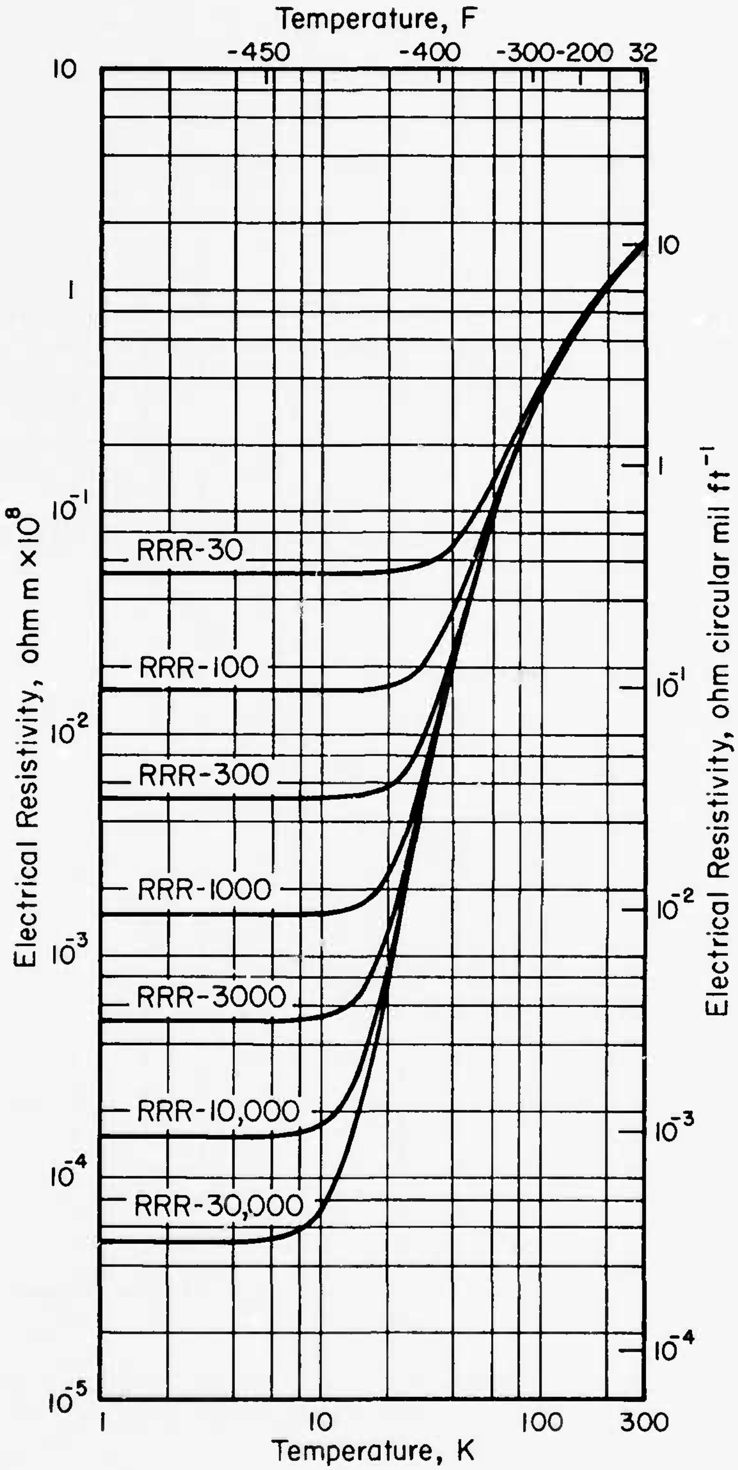

FIGURE 5.1.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER

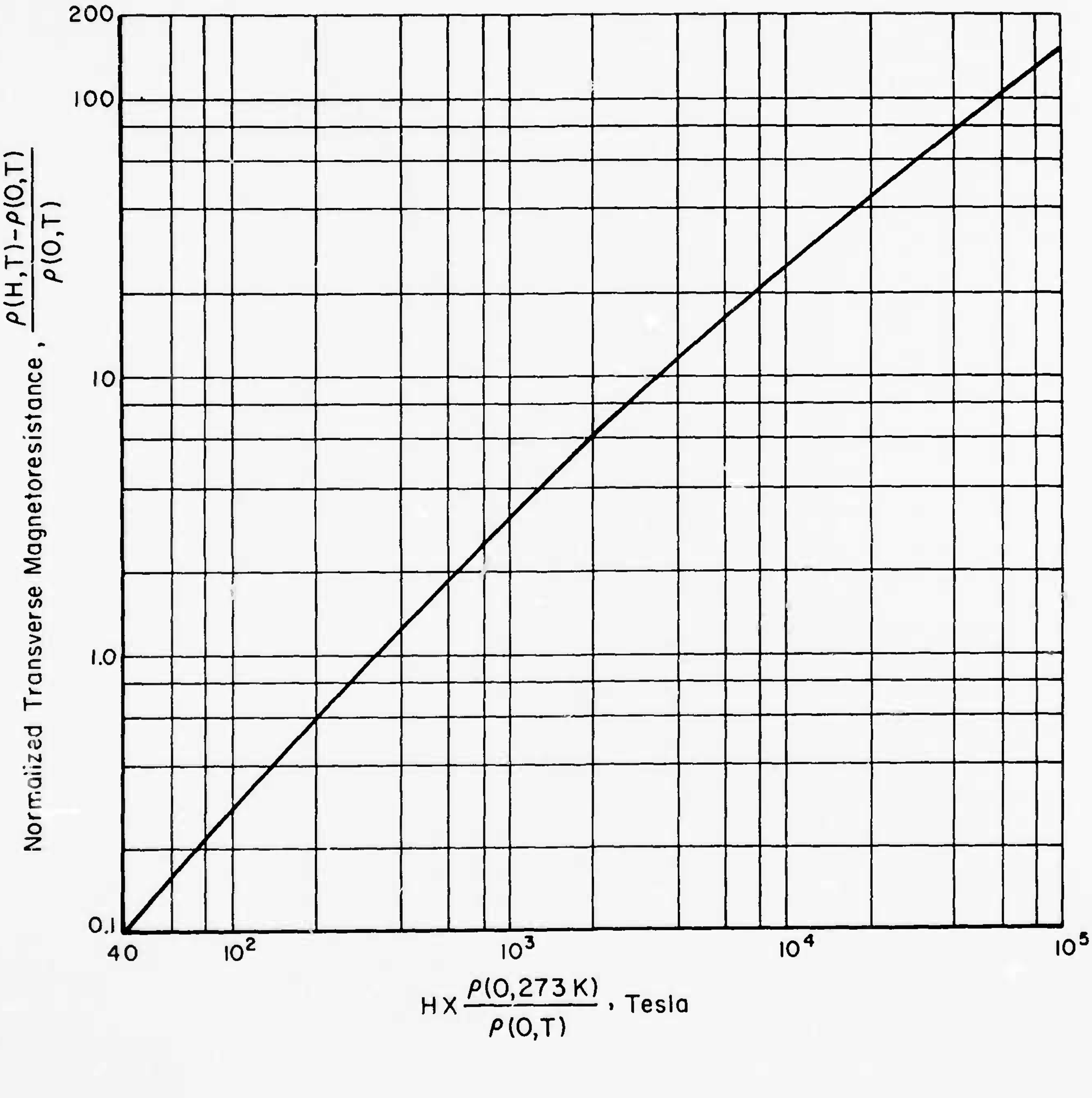

FIGURE 5.1.1-MR1. TRANSVERSE MAGNETORESISTANCE (ELECTRICAL) OF COPPER (REDUCED KOHLER PLOT)

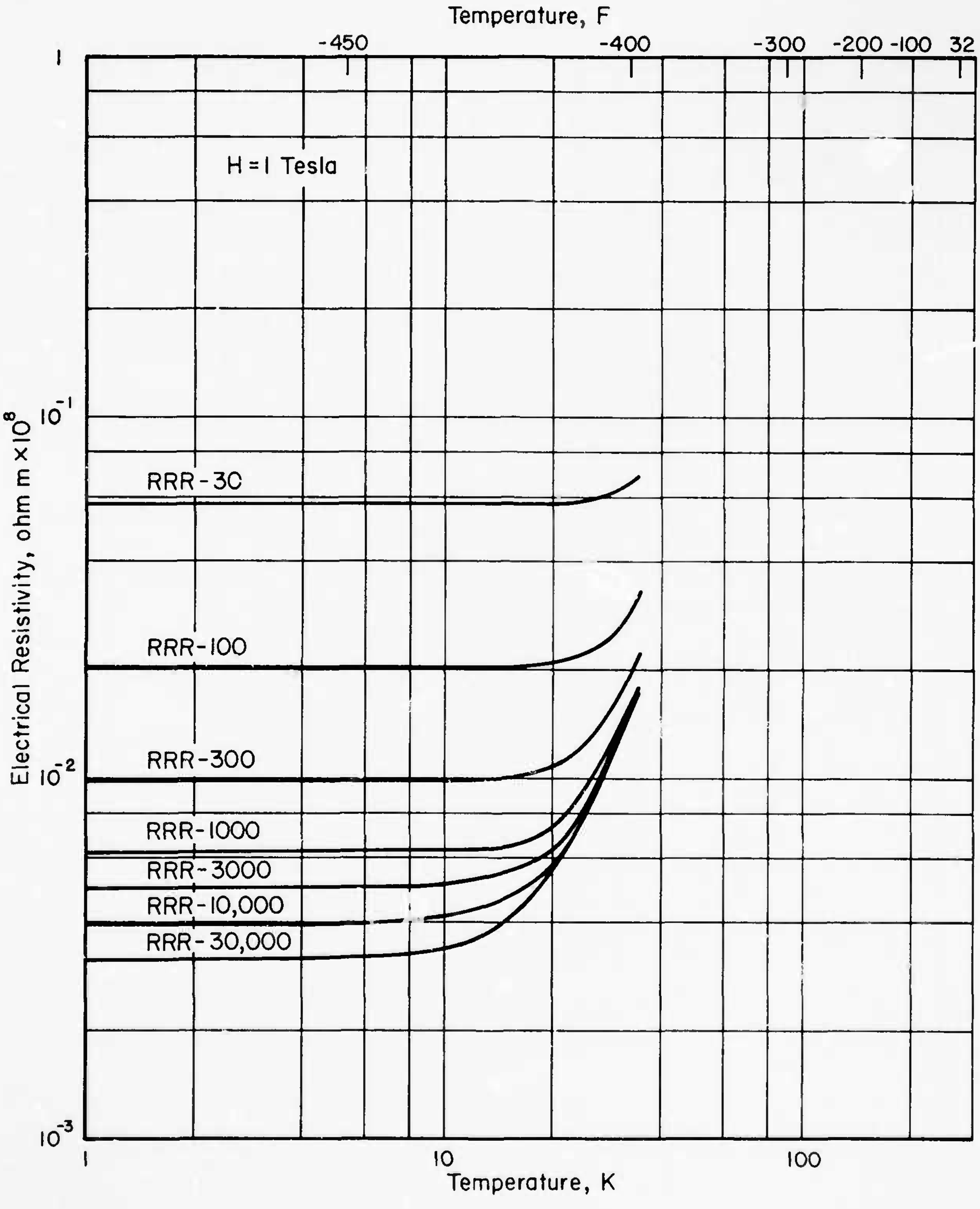

FIGURE 5.1.1-MR2. TRANSVERSE MAGNETORESISTANCE OF COPPER AT 1 TESLA

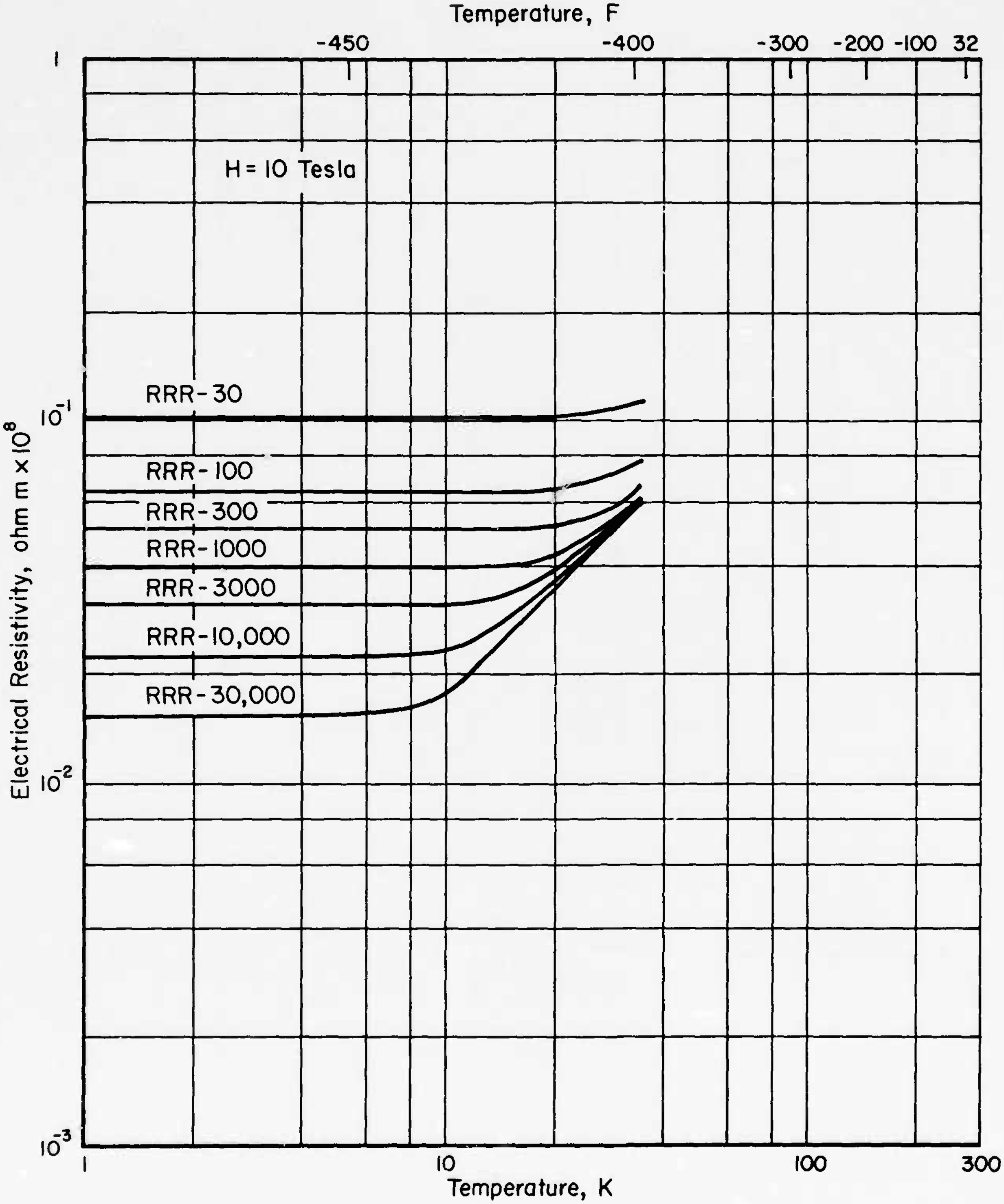

FIGURE 5.1.1-MR3. TRANSVERSE MAGNETORESISTANCE OF COPPER AT 10 TESLA

TABLE 5.1.1-MA1

Alloy Designation: 99.999 Cu (<1 ppm Fe or Ni)*

Specification:

Form: Wire

Diameter, cm (in.): 0.03 (0.0118)

Condition: Cold drawn, etched, and annealed.

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Susceptibility, k (mksa)	Permeability, μ (mksa)
1.450 (-457)	-0.673×10^{-7}	-75.71×10^{-7}	$\sim 12.57 \times 10^{-7}$
2.155 (-456)	-0.706×10^{-7}	-79.43×10^{-7}	$\sim 12.57 \times 10^{-7}$
3.003 (-454)	-0.735×10^{-7}	-82.69×10^{-7}	$\sim 12.57 \times 10^{-7}$
4.187 (-452)	-0.771×10^{-7}	-86.74×10^{-7}	$\sim 12.57 \times 10^{-7}$
10 ± 1 (-442)	-0.795×10^{-7}	-89.44×10^{-7}	$\sim 12.57 \times 10^{-7}$
13.8 (-434)	-0.802×10^{-7}	-90.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
16.3 (-430)	-0.812×10^{-7}	-91.35×10^{-7}	$\sim 12.57 \times 10^{-7}$
18.1 (-427)	-0.816×10^{-7}	-91.80×10^{-7}	$\sim 12.57 \times 10^{-7}$
20.2 (-423)	-0.821×10^{-7}	-92.36×10^{-7}	$\sim 12.57 \times 10^{-7}$
77 (-321)	-0.816×10^{-7}	-91.80×10^{-7}	$\sim 12.57 \times 10^{-7}$
300 (80)	-0.830×10^{-7}	-93.38×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 96873

* American Smelting and Refining Company.

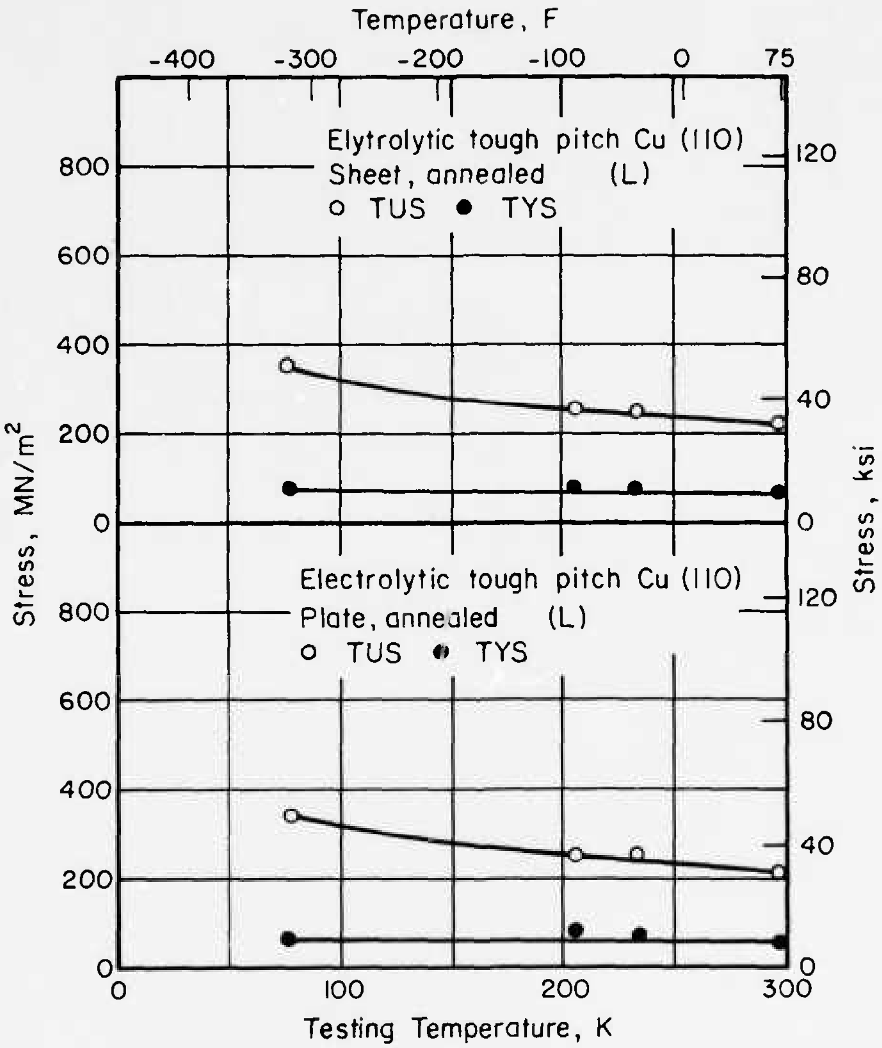

FIGURE 5.1.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF ELECTROLYTIC TOUGH PITCH COPPER

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TABLE 5.1.2-TR1

Alloy Designation: Copper-Electrolytic Tough Pitch

Specification: CDA No. 110
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}		445	880	1320	750	325
Btu hr^{-1} ft^{-1} F^{-1}		(257)	(509)	(763)	(434)	(188)
No. of Spec.		1	1	2	2	2
References: 90244, 90300						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

290<

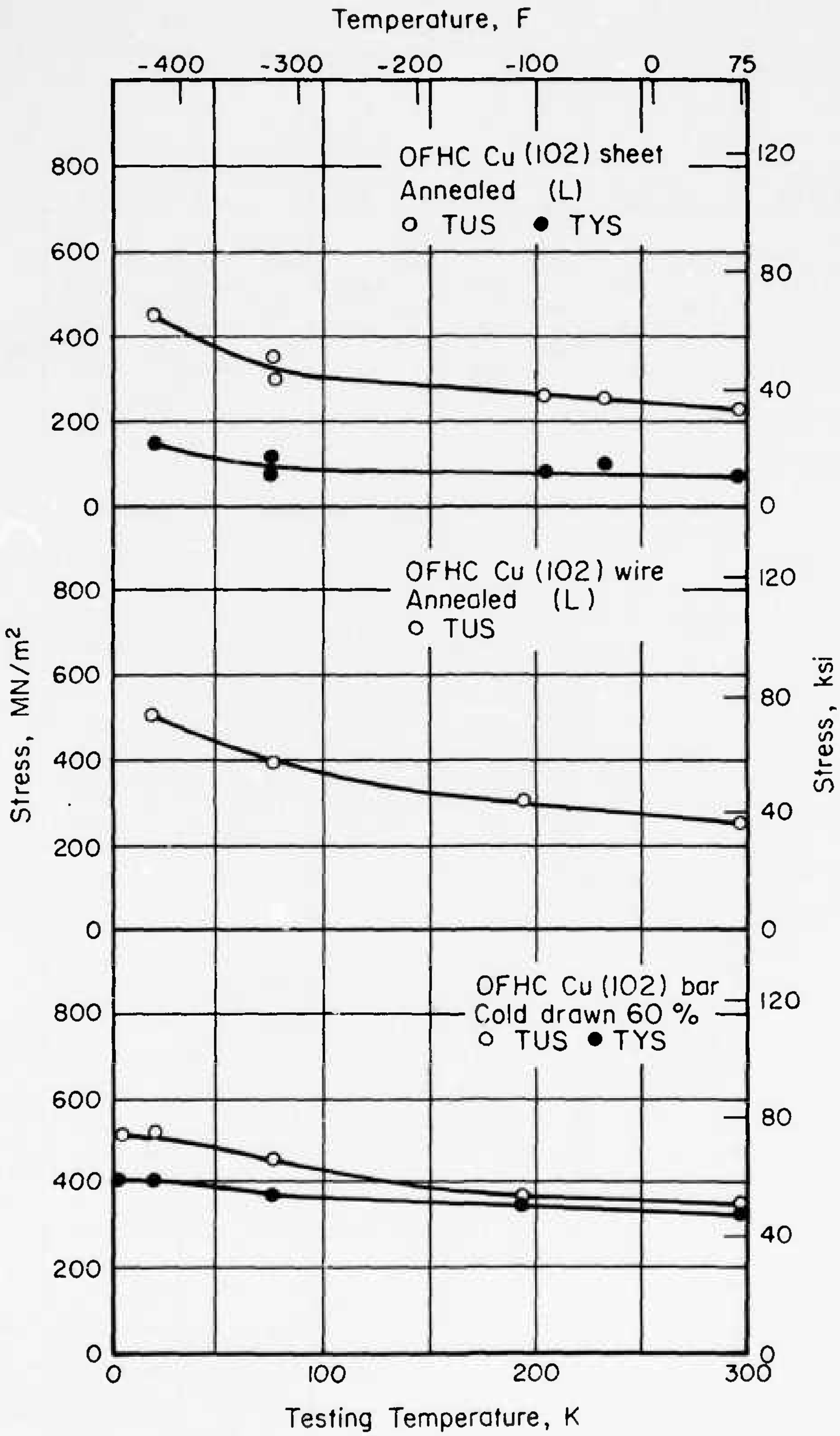

FIGURE 5.1.3-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF OFHC Cu

TABLE 5.1.3-TR1

Alloy Designation:	Copper-OFHC
Specification:	CDA No. 102
Form:	
Thickness, cm (in.):	
Condition:	Annealed

Testing Temperature, K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
RRR-250 Watts m^{-1} K^{-1}	412		480		1150		4050		3230			
Btu hr^{-1} ft^{-1} F^{-1}		(238)		(278)		(665)		(2340)		(1870)		
RRR-107 Watts m^{-1} K^{-1}	406*		460*		1000*		2150		1450			
Btu hr^{-1} ft^{-1} F^{-1}		(235)*		(266)*		(578)*		(1240)		(838)		
RRR-97 Watts m^{-1} K^{-1}	400		440		820		900		460		183	
Btu hr^{-1} ft^{-1} F^{-1}		(231)		(254)		(474)		(520)		(266)		(106)
No. of Spec.	2		2		2		3		3		1	
References: 90111, 94206												
Thermal Expansion (T_{273} to T)												
Longitudinal												
Percent	0		-0.252		-0.288		-0.295		-0.295			
No. of Spec.	3		3		4		4		1			
References: 90202, 90252, 90366, 90459												
Specific Heat												
Joules kg^{-1} K^{-1}	380		245		95		7.2		0.85		0.099	
Btu lb^{-1} F^{-1}		(0.091)		(0.0586		(0.0227)		(0.00172)		(0.000203)		(0.0000239)
No. of Spec.	2		2		1		2		3		3	
References: 90223, 90259, 94206												
Electrical Resistivity												
RRR-250 Ohm m	1.55×10^{-8}		3.54×10^{-9}		5.82×10^{-10}		8.10×10^{-11}		7.30×10^{-11}			
Ohm circular mil ft^{-1}		(9.32)		(2.13)		(0.350)		(4.87×10^{-2})		(4.39×10^{-2})		
RRR-97 Ohm m	1.55×10^{-8}		3.40×10^{-9}		5.10×10^{-10}		1.72×10^{-10}		1.65×10^{-10}		1.60×10^{-10}	
Ohm circular mil ft^{-1}		(9.32)		(2.05)		(0.307)		(0.103)		(0.0992)		(0.0962)
No. of Spec.	3		3		3		3		3			
References: 79561, 90111, 94206												
Magnetothermal Conductivity(1) H tesla												
Watts m^{-1} K^{-1} — 0							2180		1450			
Btu hr^{-1} ft^{-1} F^{-1}								(1260)		(838)		
Watts m^{-1} K^{-1} — 1							2060		1250			
Btu hr^{-1} ft^{-1} F^{-1}								(1191)		(723)		
Watts m^{-1} K^{-1} — 2							1880		1080			
Btu hr^{-1} ft^{-1} F^{-1}								(1087)		(624)		
Watts m^{-1} K^{-1} — 4							1530		940			
Btu hr^{-1} ft^{-1} F^{-1}								(885)		(544)		
Watts m^{-1} K^{-1} — 8							1202		730			
Btu hr^{-1} ft^{-1} F^{-1}								(695)		(422)		
No. of Spec.							1					
References: 94206												
Magnetoresistance(2) H tesla												
Ohm m — 0							8.32×10^{-11}		7.54×10^{-11}		7.52×10^{-11}	
Ohm circular mil ft^{-1}								(5.00×10^{-2})		(4.54×10^{-2})		(4.52×10^{-2})
Ohm m — 1							1.29×10^{-10}		1.22×10^{-10}		1.22×10^{-10}	
Ohm circular mil ft^{-1}								(7.76×10^{-2})		(7.34×10^{-2})		(7.34×10^{-2})
Ohm m — 10							5.48×10^{-10}		5.37×10^{-10}		5.37×10^{-10}	
Ohm circular mil ft^{-1}								(0.330)		(0.323)		(0.323)
No. of Spec.							1		1		1	
References: 96887												

(1) RRR-107.
(2) RRR-207.
* Extrapolated.

TABLE 4.3.1-ME3.6

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5556 Alloy filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	306 (44.4)	319 (46.3)		450 (65.3)		474 (68.8)
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	177 (25.6)	184 (26.7)		211 (30.6)		239 (34.6)
	Min						
Std. Deviation							
Elong, percent	Avg	14.0	18.5		20.5		13.0
	Min						
RA, percent	Avg	36	46		26		17
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	370 (53.7)	401 (58.1)		417 (60.5)		399 (57.9)
K_t = 16	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.3.1-ME3.7

Alloy Designation: 5083-O Aluminum Alloy (Weld Metal)

Specification:
Form: Plate-MIG welded, 5183 Alloy filler
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	295 (42.8)			419 (60.8)		
	Min	280 (40.6)			405 (58.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	146 (21.2)			177 (25.6)		
	Min	129 (18.7)			160 (23.2)		
Std. Deviation							
Elong, percent	Avg	22.5			24.5		
	Min	17.7			20.8		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (1)			10 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

294<

References: 96694

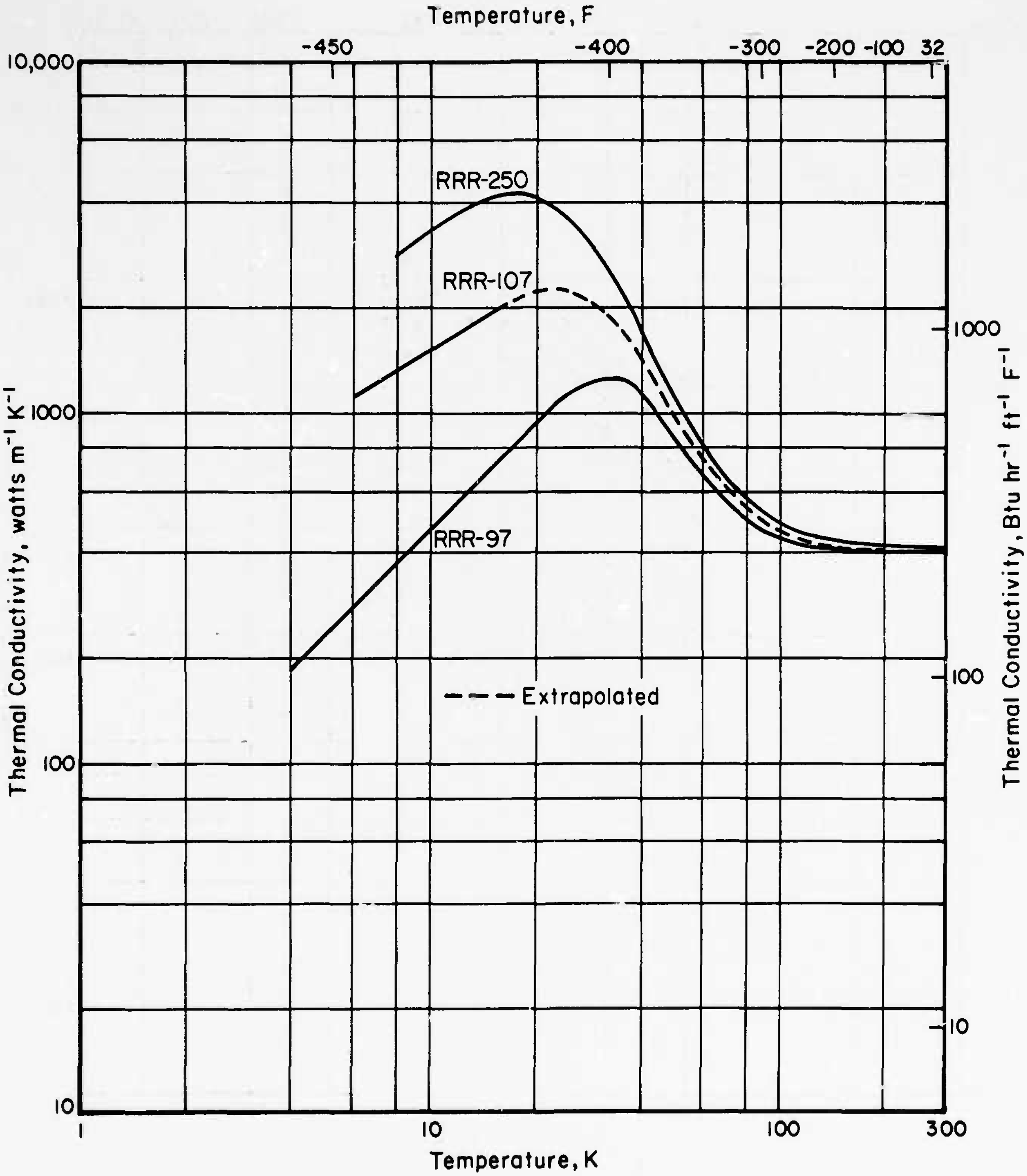

FIGURE 5.1.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR OFHC COPPER

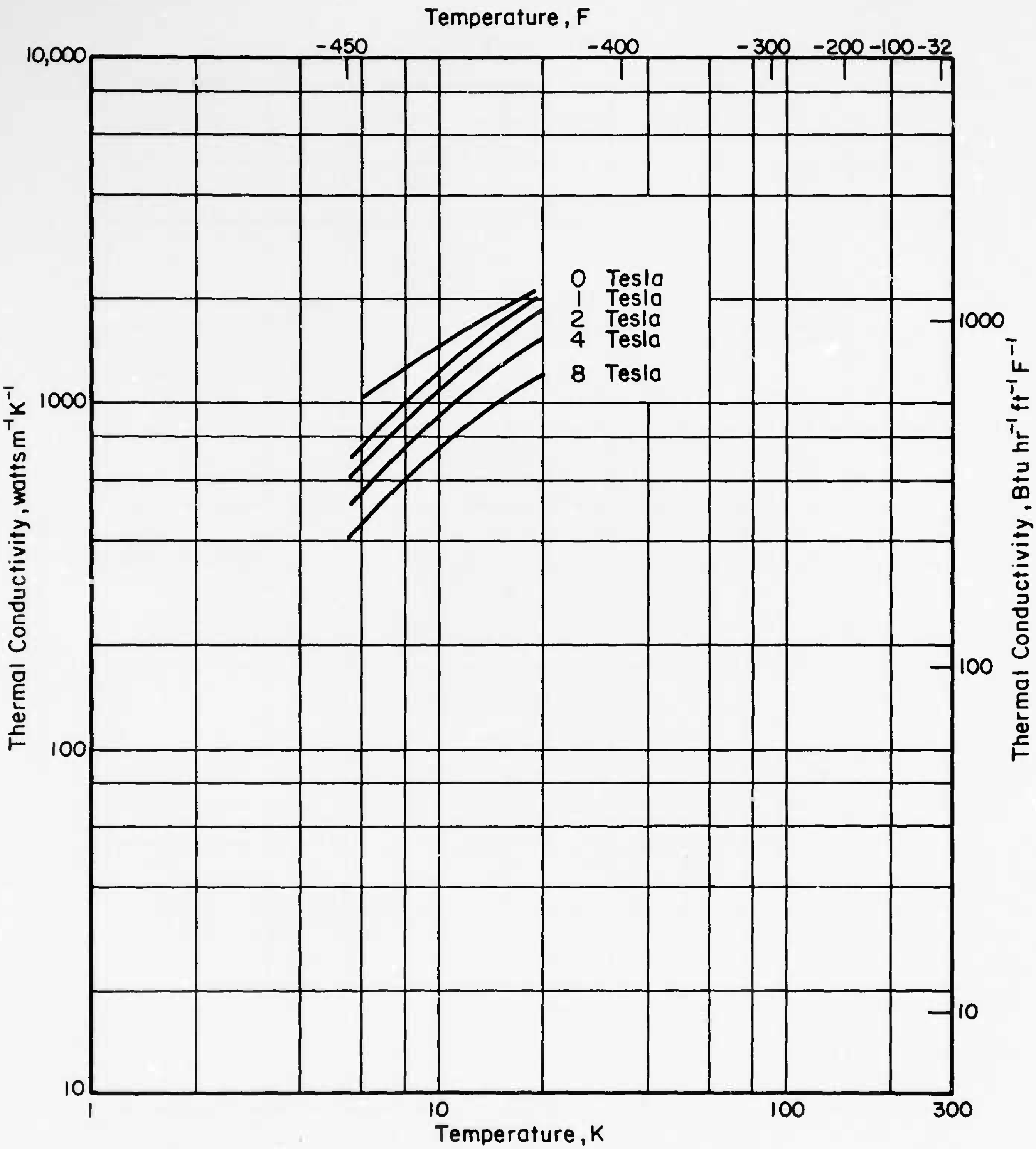

FIGURE 5.1.3-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR OFHC COPPER AT SEVERAL MAGNETIC FIELD STRENGTHS

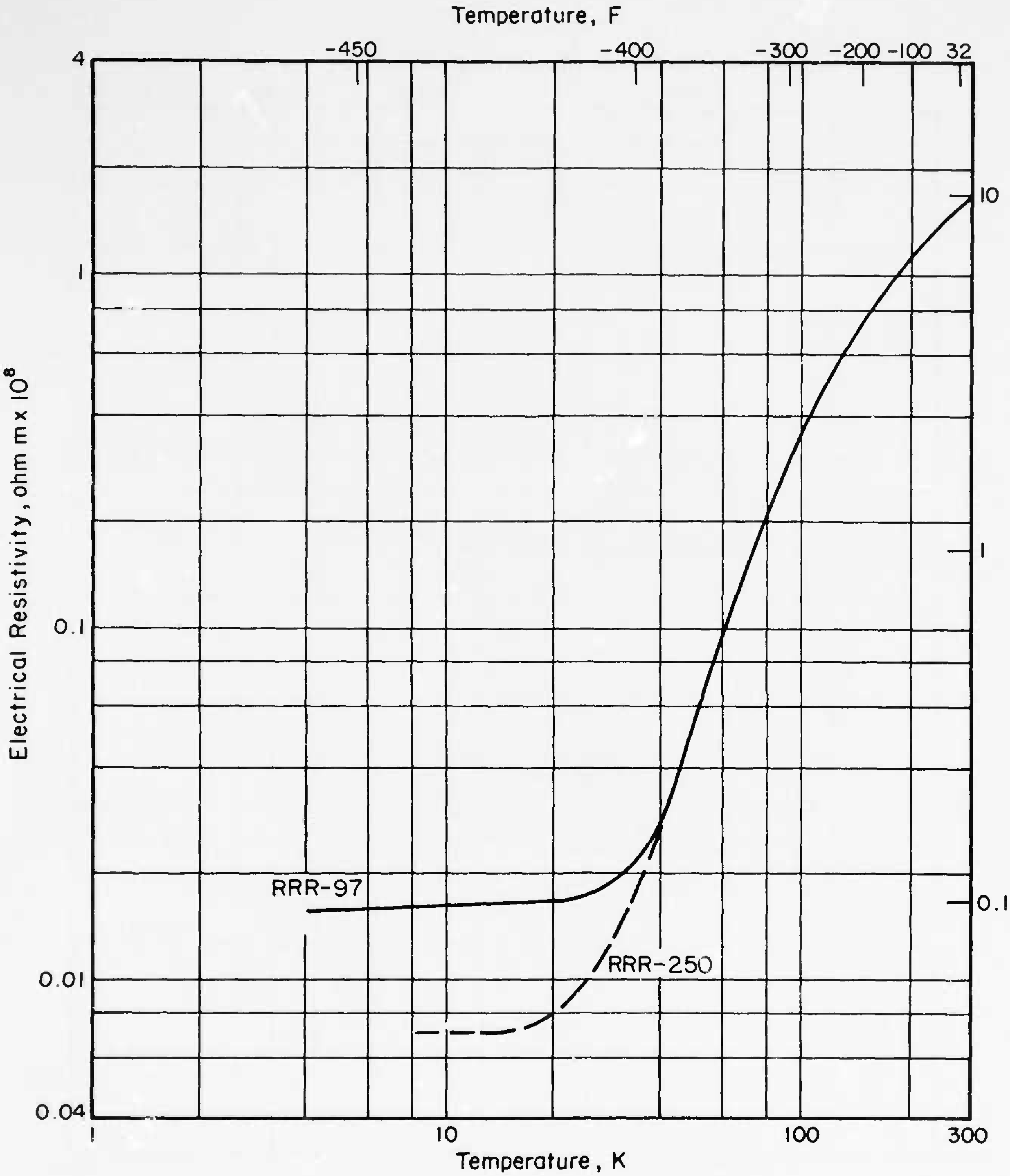

FIGURE 5.1.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR OFHC COPPER

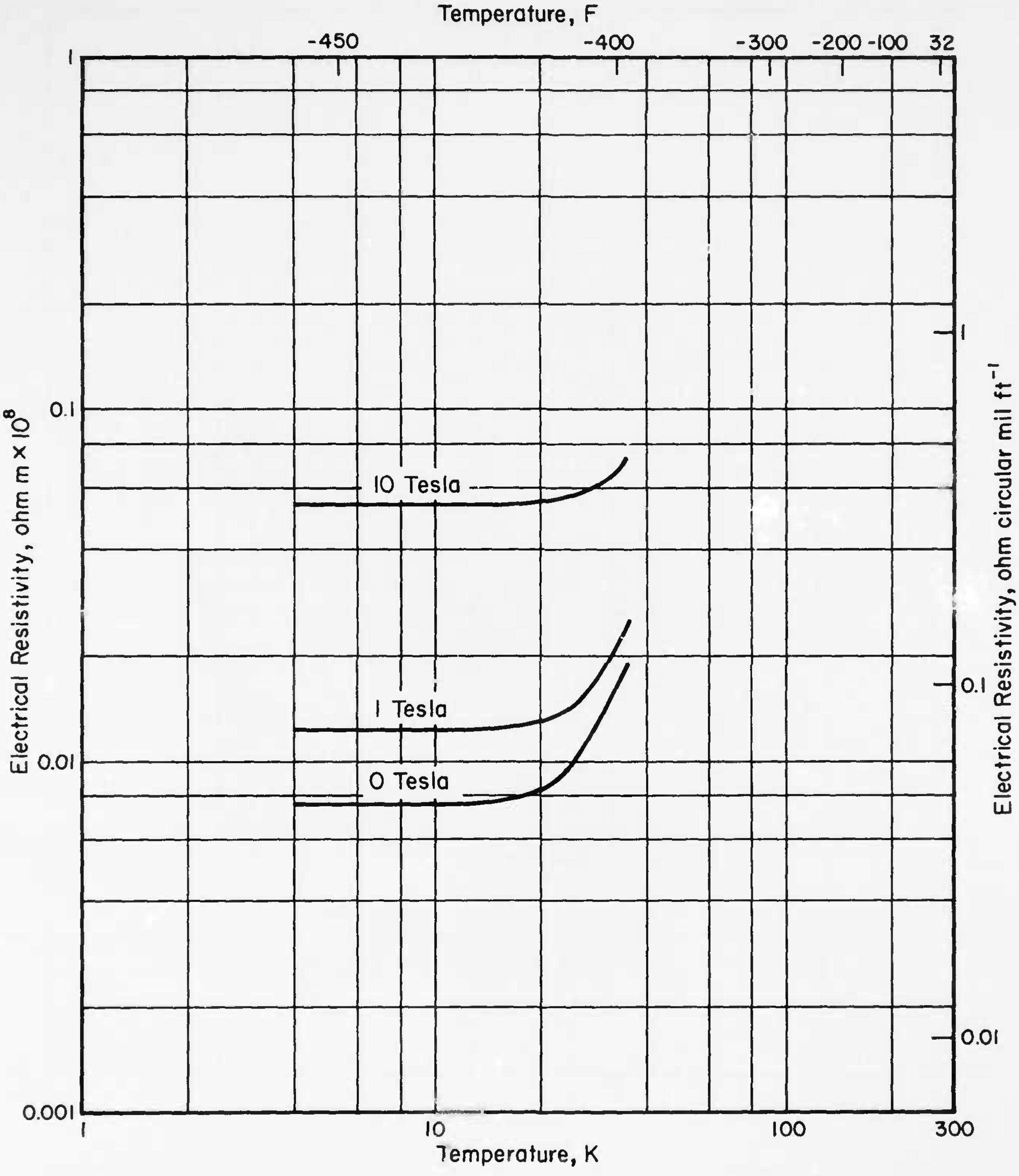

FIGURE 5.1.3-MR1. MAGNETORESISTANCE VERSUS TEMPERATURE FOR OFHC COPPER

TABLE 5.1.3-MA1

Alloy Designation:	OFHC Cu
Specification:	
Form:	Rod
Diameter, cm (in.):	0.9 (0.354)
Condition:	Heavily etched and air cooled after annealing at 823 K (550 C) for 7 days

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Susceptibility, k (mksa)	Permeability, μ (mksa)
6.6 (-447)	-0.836×10^{-7}	-89.32×10^{-7}	$\sim 12.57 \times 10^{-7}$
22.6 (-418)	-0.856×10^{-7}	-91.46×10^{-7}	$\sim 12.57 \times 10^{-7}$
30.8 (-404)	-0.863×10^{-7}	-92.21×10^{-7}	$\sim 12.57 \times 10^{-7}$
40.5 (-386)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
48.2 (-372)	-0.872×10^{-7}	-93.17×10^{-7}	$\sim 12.57 \times 10^{-7}$
62.0 (-347)	-0.873×10^{-7}	-93.28×10^{-7}	$\sim 12.57 \times 10^{-7}$
80.0 (-315)	-0.872×10^{-7}	-93.17×10^{-7}	$\sim 12.57 \times 10^{-7}$
98.8 (-281)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
128.0 (-229)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
160.1 (-171)	-0.867×10^{-7}	-92.63×10^{-7}	$\sim 12.57 \times 10^{-7}$
208.0 (-85.0)	-0.863×10^{-7}	-92.21×10^{-7}	$\sim 12.57 \times 10^{-7}$
247.5 (-13.9)	-0.859×10^{-7}	-91.78×10^{-7}	$\sim 12.57 \times 10^{-7}$
292.0 (66.2)	-0.855×10^{-7}	-91.35×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 90467

TABLE 5.1.4-TR1

Alloy Designation: Copper-Phosphorized

Specification: CDA No. 122
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	201		140		92		43		20.2			
Btu hr^{-1} ft^{-1} F^{-1}		(116)		(80.9)		(53.2)		(24.9)		(11.7)		
No. of Spec.	1		2		2		2		2			
References: 90224, 90330												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

300<

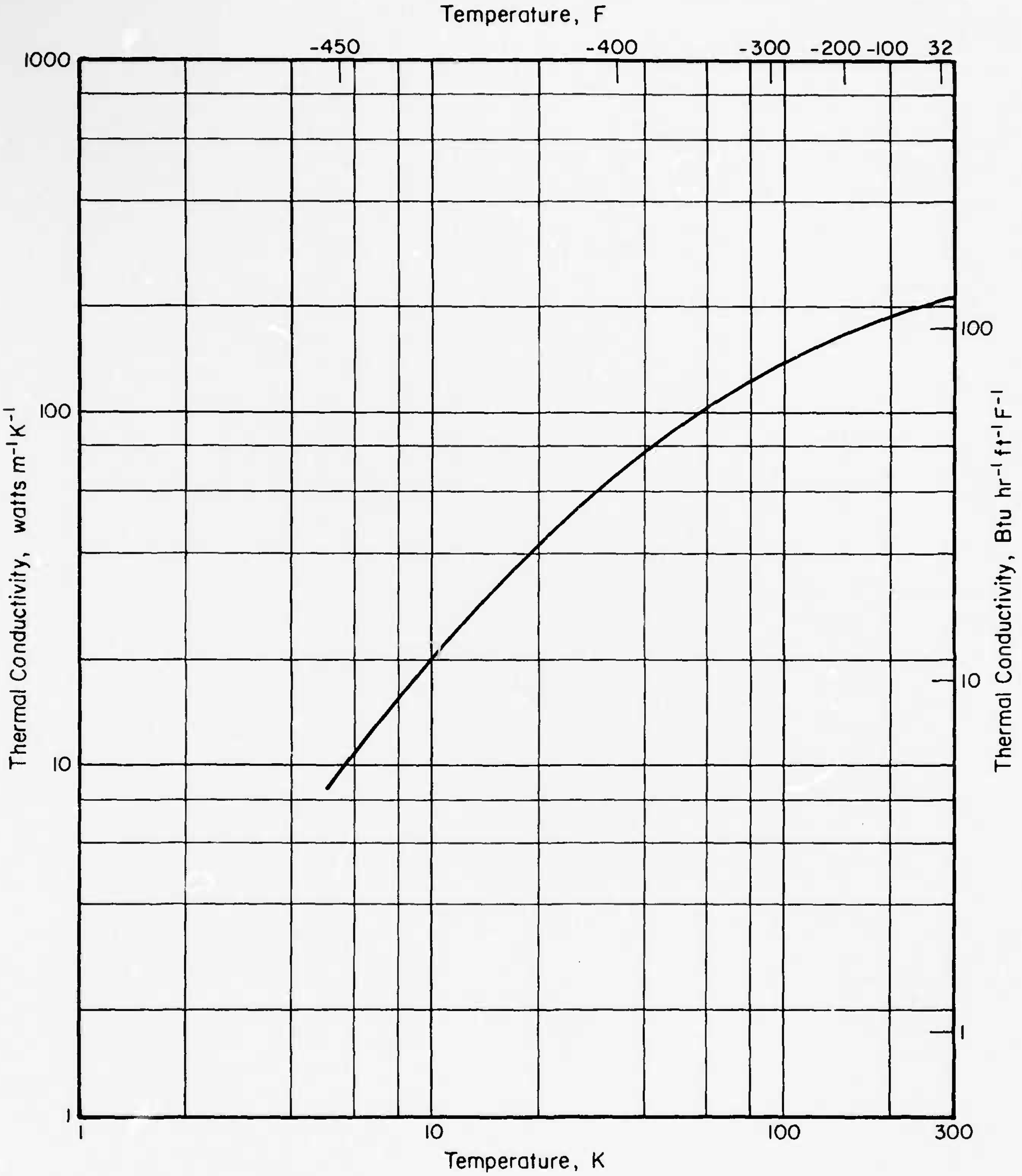

FIGURE 5.1.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR PHOSPHORIZED COPPER

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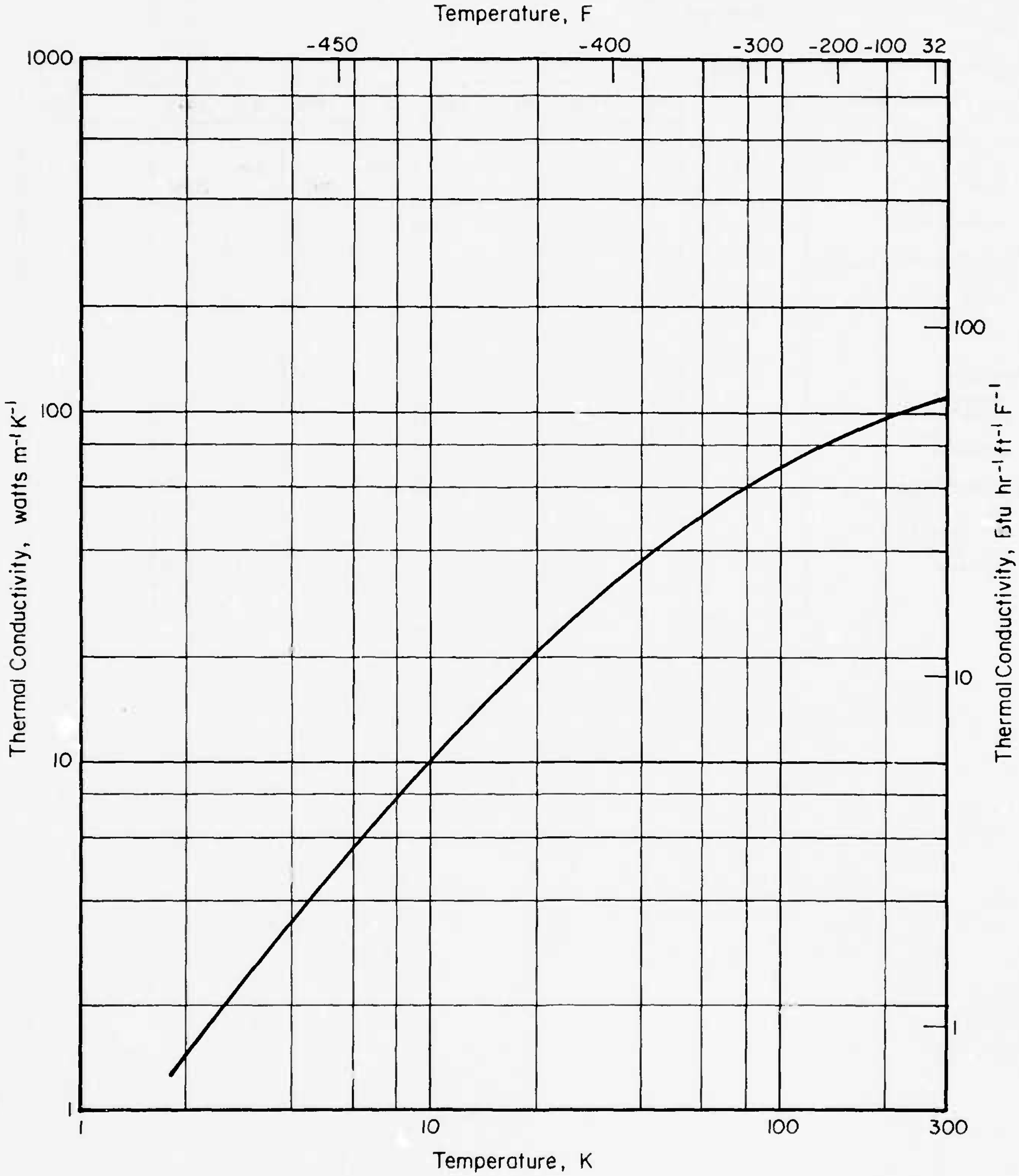

FIGURE 5.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70 Cu-30 Zn

TABLE 5.2.2-TR2

Alloy Designation: 70Cu-30Ni Alloy

Specification: CDA No. 715
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}							5.02		2.09			
Btu hr^{-1} ft^{-1} F^{-1}								(290)		(1.21)		
No. of Spec.							1		1			
References: 90224												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

303

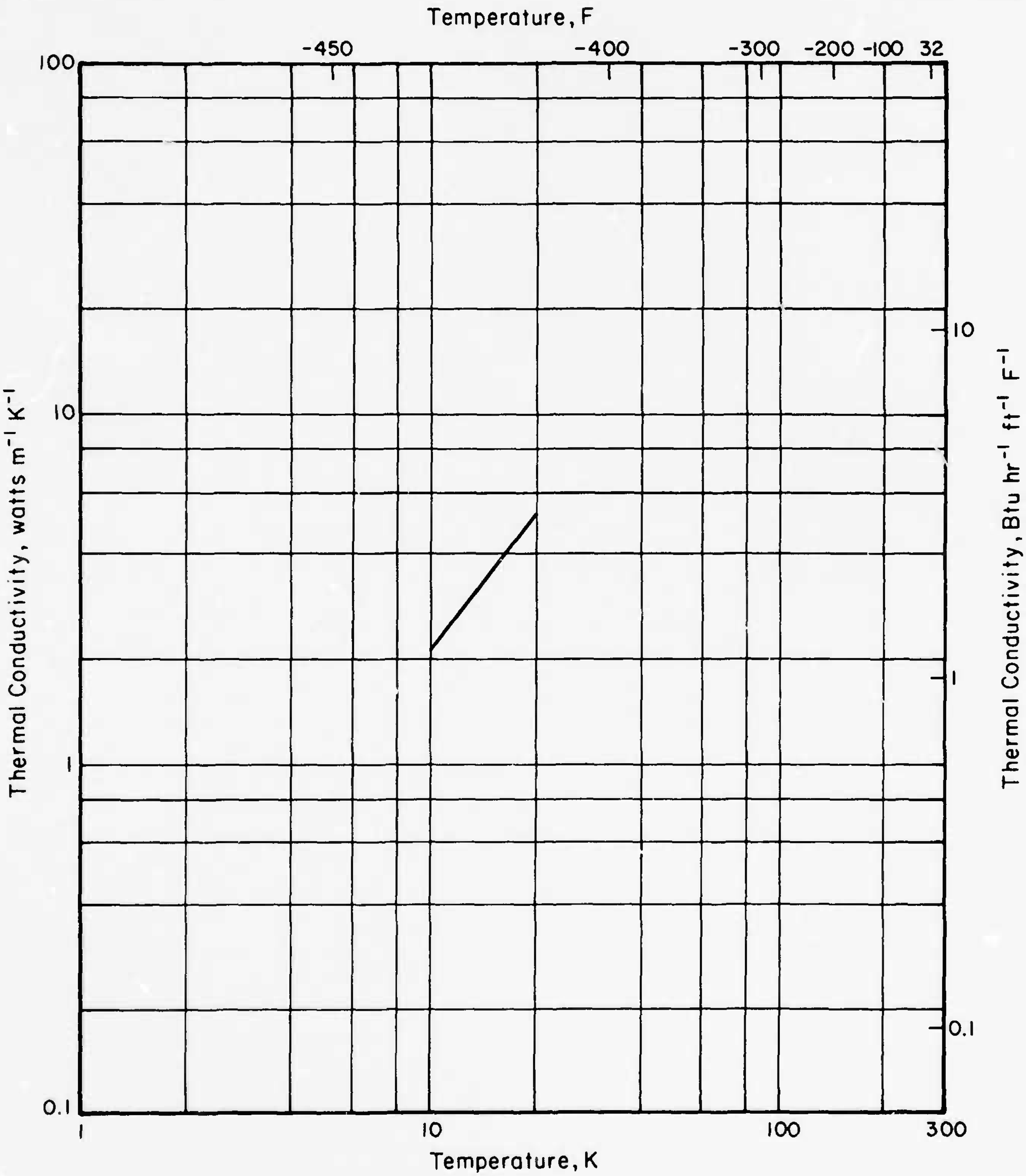

FIGURE 5.2.2-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

TABLE 5.2.4-ME1

Alloy Designation:	90Cu-10Zn Alloy (Commercial Bronze)
Specification:	CDA No. 220
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	265 (38.5)	288 (41.8)		381 (55.2)	505 (73.2)	470 (68.2)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	66.2 (9.6)	70.3 (10.2)		91.0 (13.2)	108 (15.6)	103 (15.0)
	Min						
Std. Deviation							
Elong, percent	Avg	56	57		86	95	91
	Min						
RA, percent	Avg	84	80		78	73	73
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
E, GN/m^2 (10^6 psi)	Avg	104 (15.1)	113 (16.4)		122 (17.7)	124 (18.0)	125 (18.1)
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	344 (49.9)	383 (55.6)		477 (69.2)	526 (76.3)	544 (78.9)
K_t = 5.0	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.2.4-ME2

Alloy Designation: 90Cu-10Zn Alloy (Commercial Bronze)

Specification: CDA No. 220
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg	45.4 (6.59)	48.1 (6.97)		49.9 (7.24)	50.8 (7.37)	
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	152 (112)	135 (114)		152 (112)	156 (115)	
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 90375

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 5.2.4-TR1

Alloy Designation:	90Cu-10Zn Alloy
Specification:	CDA No. 220
Form:	
Dimension:	
Condition:	Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}			82.0	42.0	19.0	6.10
Btu hr^{-1} ft^{-1} F^{-1}			(47.4)	(24.3)	(11.0)	(3.53)
No. of Spec.			2	2	2	2
References: 90224, 90317						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}	376	259	105	8.0	0.87	0.096
Btu lb^{-1} F^{-1}	(8.49×10^{-2})	(6.19×10^{-2})	(2.51×10^{-2})	1.91×10^{-3})	(2.08×10^{-4})	(2.29×10^{-5})
No. of Spec.	1	1	1	1	1	1
References: 90223, 90314						
Electrical Resistivity						
Ohm m	3.90×10^{-8}	2.45×10^{-8}	2.05×10^{-8}	1.98×10^{-8}	1.98×10^{-8}	1.98×10^{-8}
Ohm circular mil ft^{-1}	(23.5)	(14.7)	(12.3)	(11.9)	(11.9)	(11.9)
No. of Spec.	3	3	3	3	3	2
References: 79561, 90317, 90348						

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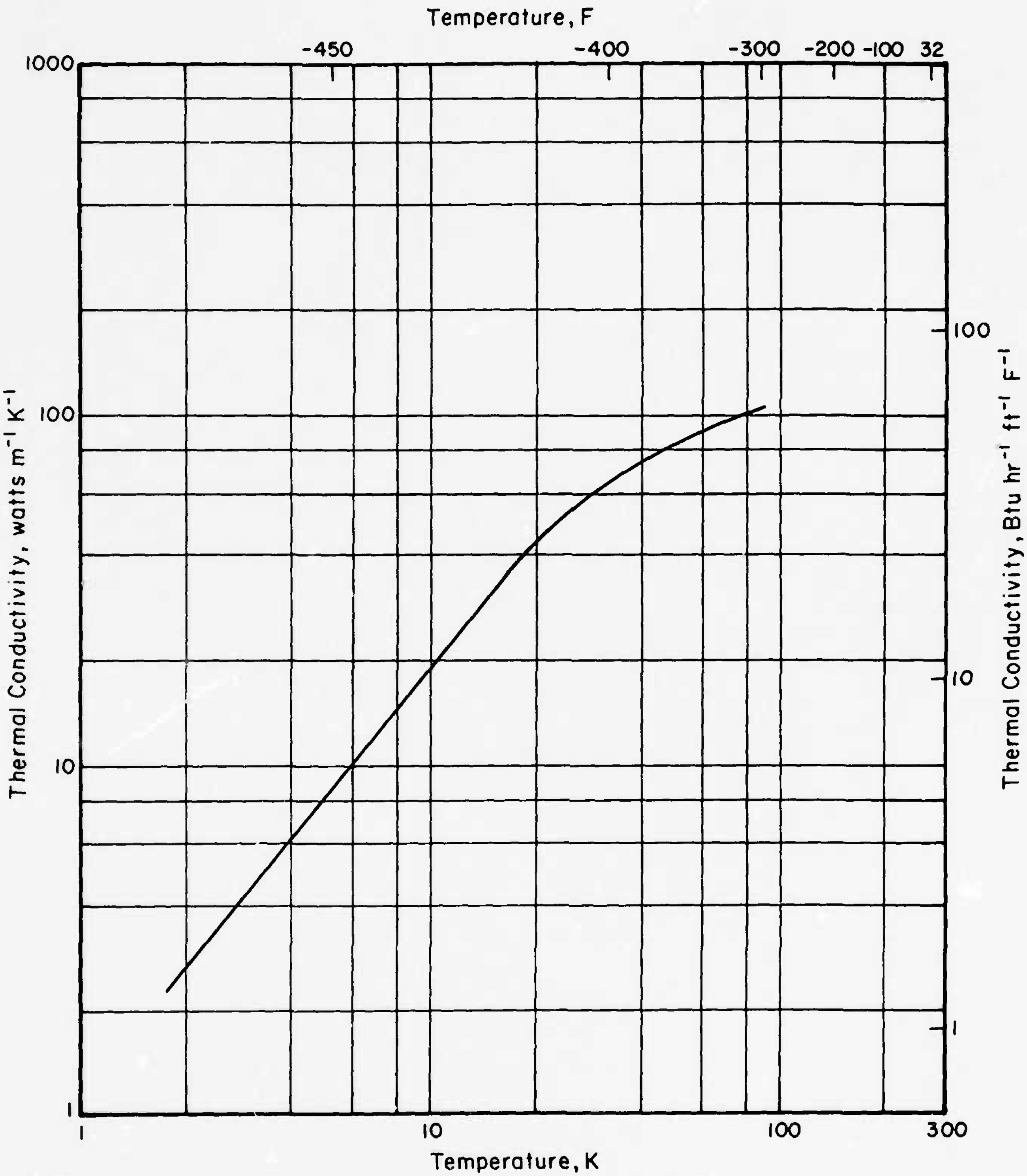

FIGURE 5.2.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

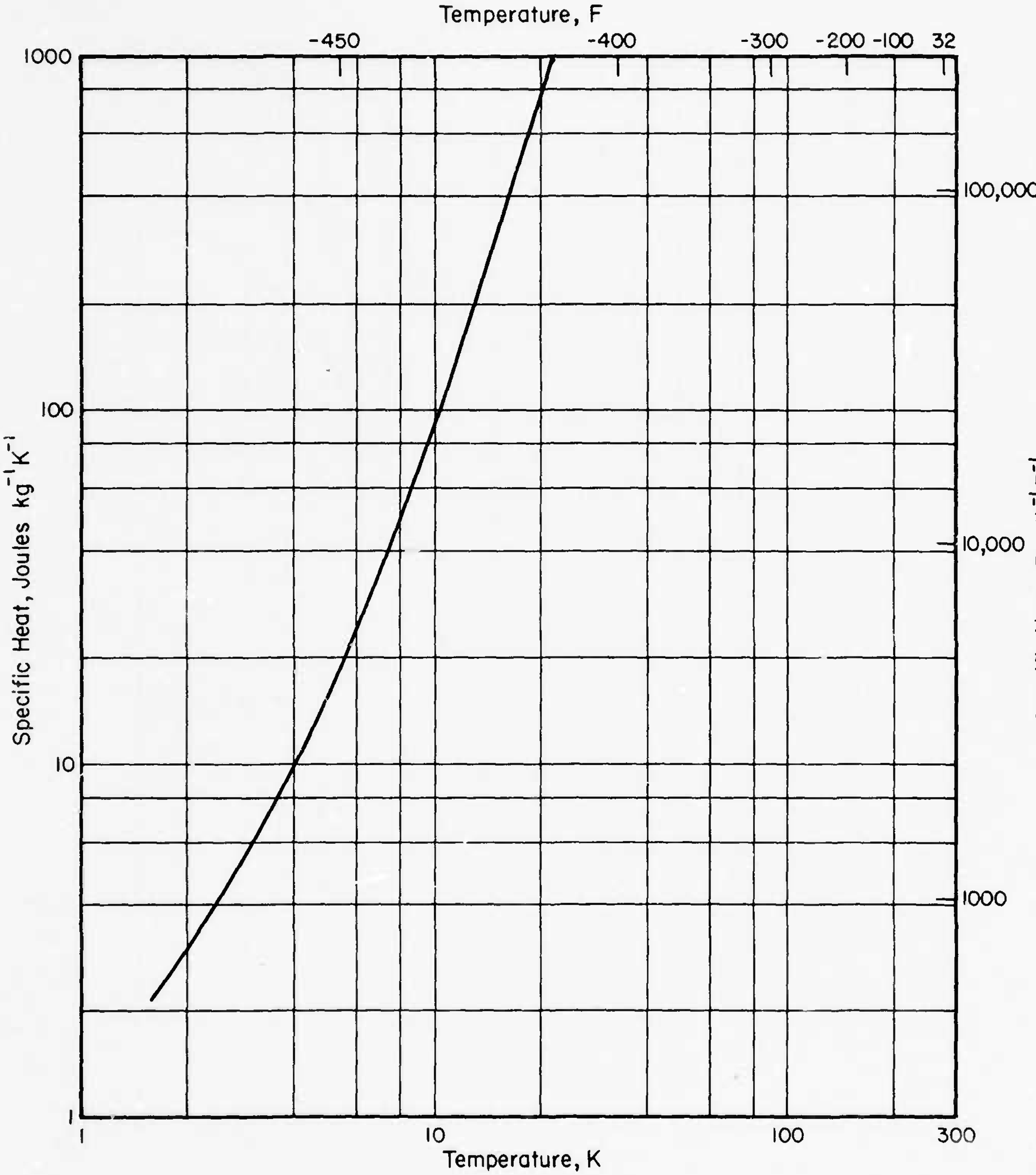

FIGURE 5.2.4-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

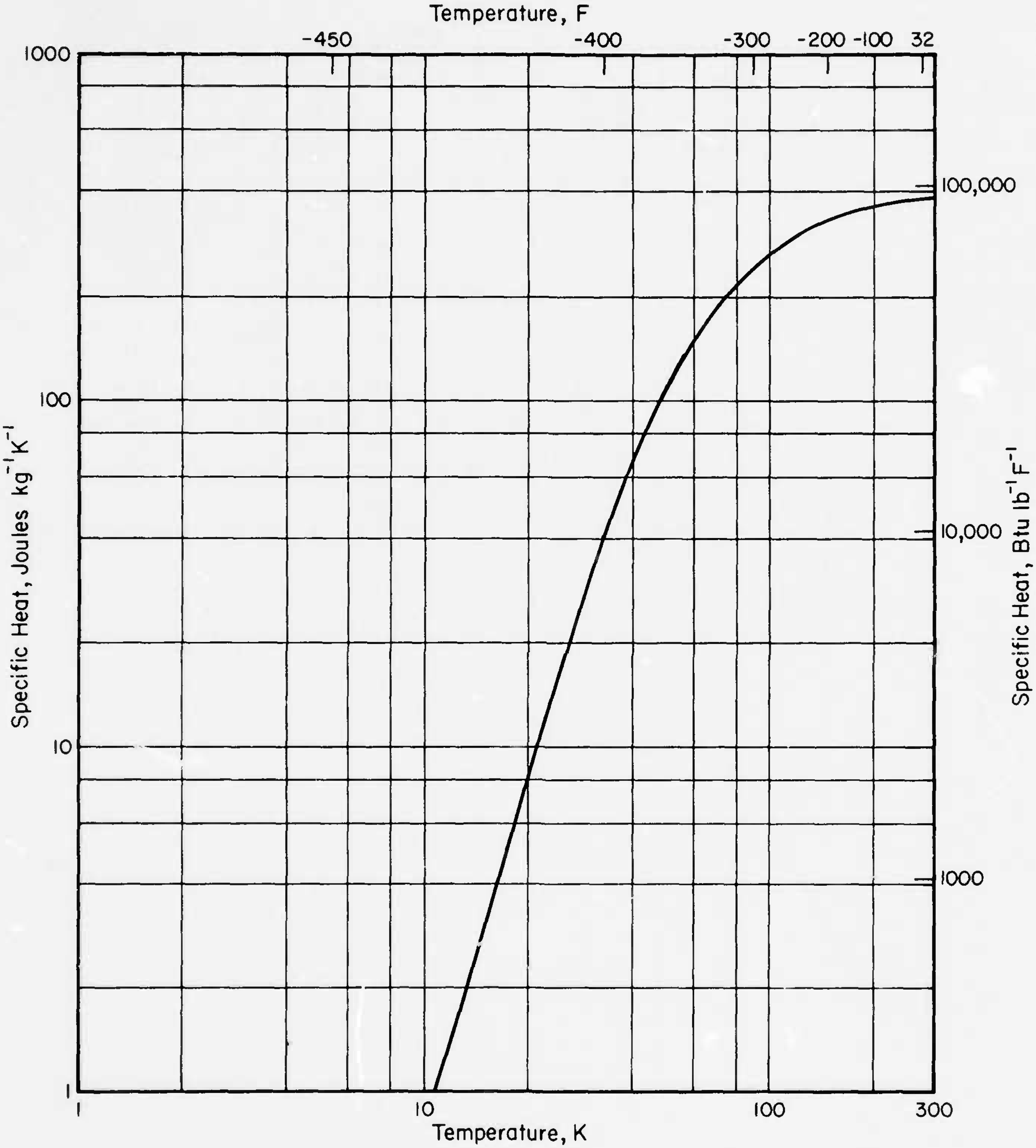

FIGURE 5.2.4-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

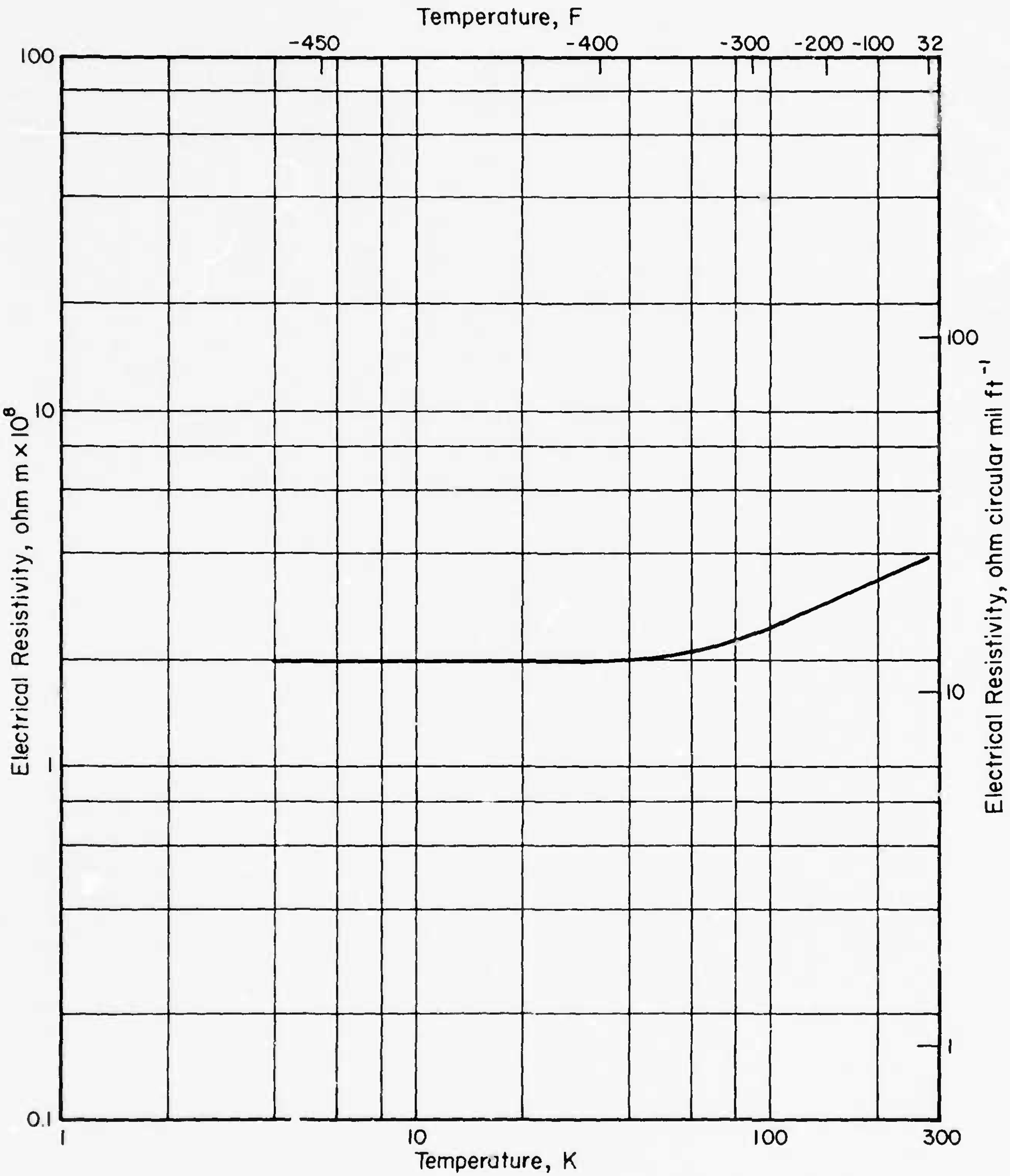

FIGURE 5.2.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

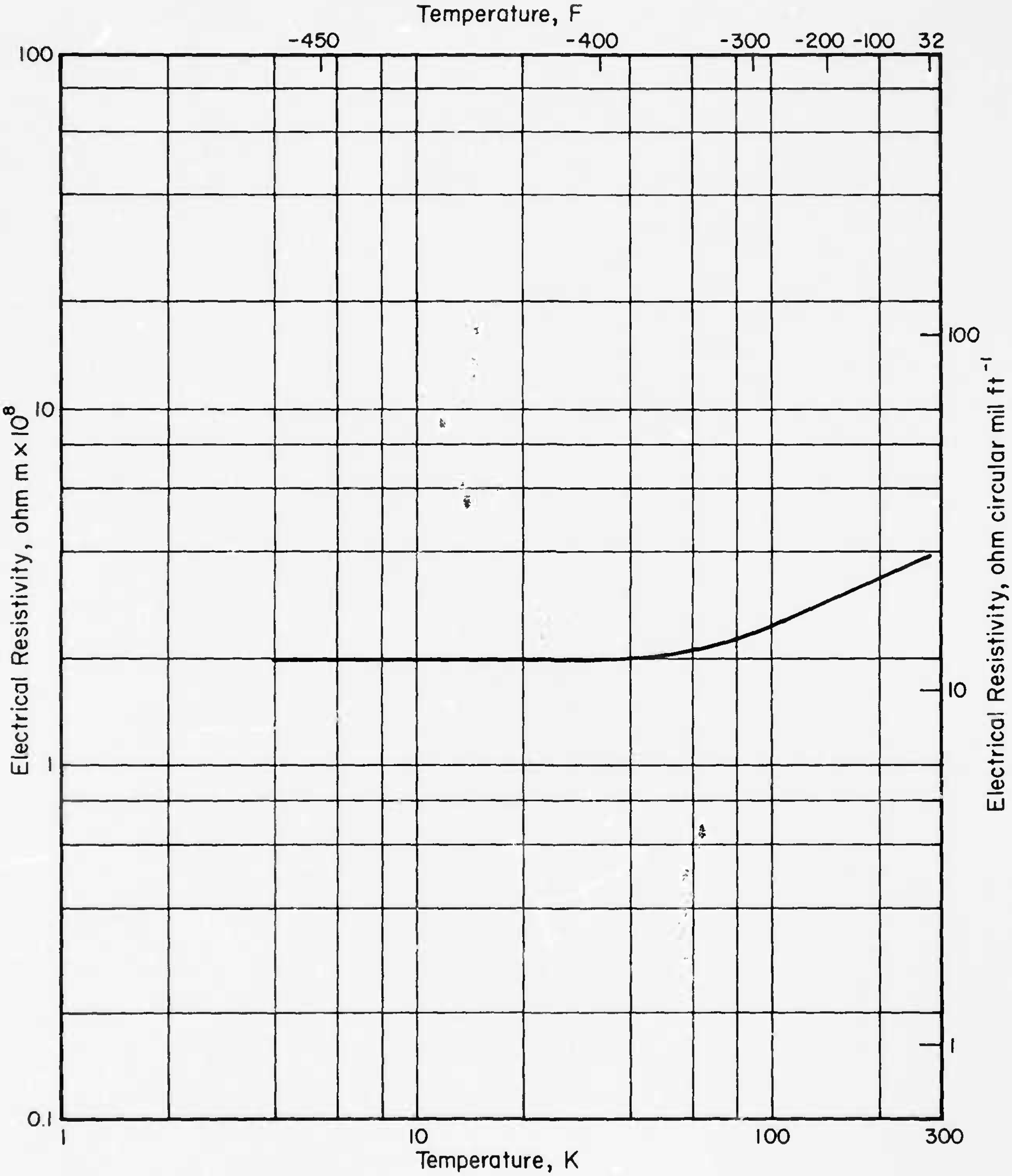

FIGURE 5.2.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

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TABLE 5.3.1-ME0.1

Alloy Designation:	90Cu-10Ni Alloy
Specification:	CDA No. 706
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Annealed (assumed)

Testing Temperature, K (F)		297 (75)	220 (-60)	173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	312 (45.3)	331 (48.0)	355 (51.5)	359 (52.1)	437 (63.4)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	278 (40.3)	285 (41.4)	294 (42.7)	299 (43.3)	321 (46.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	37	38	42	42	46	
	Min						
RA, percent	Avg	68.5	65	67.5	64	50.5	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96688

TABLE 5.3.1-TR1

Alloy Designation: 90Cu-10Ni Alloy

Specification: CDA No. 706
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}			32.5	16.7	5.80	1.30
Btu hr^{-1} ft^{-1} F^{-1}			(18.8)	(9.66)	(3.35)	(0.752)
No. of Spec.			2	2	2	2
References: 90318, 96875						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						0.112
Btu lb^{-1} F^{-1}						(0.0000268)
No. of Spec.						1
References: 90223						
Electrical Resistivity						
Ohm m	16.4×10^{-8}	15.1×10^{-8}	14.6×10^{-8}	14.1×10^{-8}	14.0×10^{-8}	14.0×10^{-8}
Ohm circular mil ft^{-1}	(98.6)	(90.8)	(87.8)	(84.8)	(84.2)	(84.2)
No. of Spec.	3	3	3	3	1	1
References: 79561, 90224, 90318						

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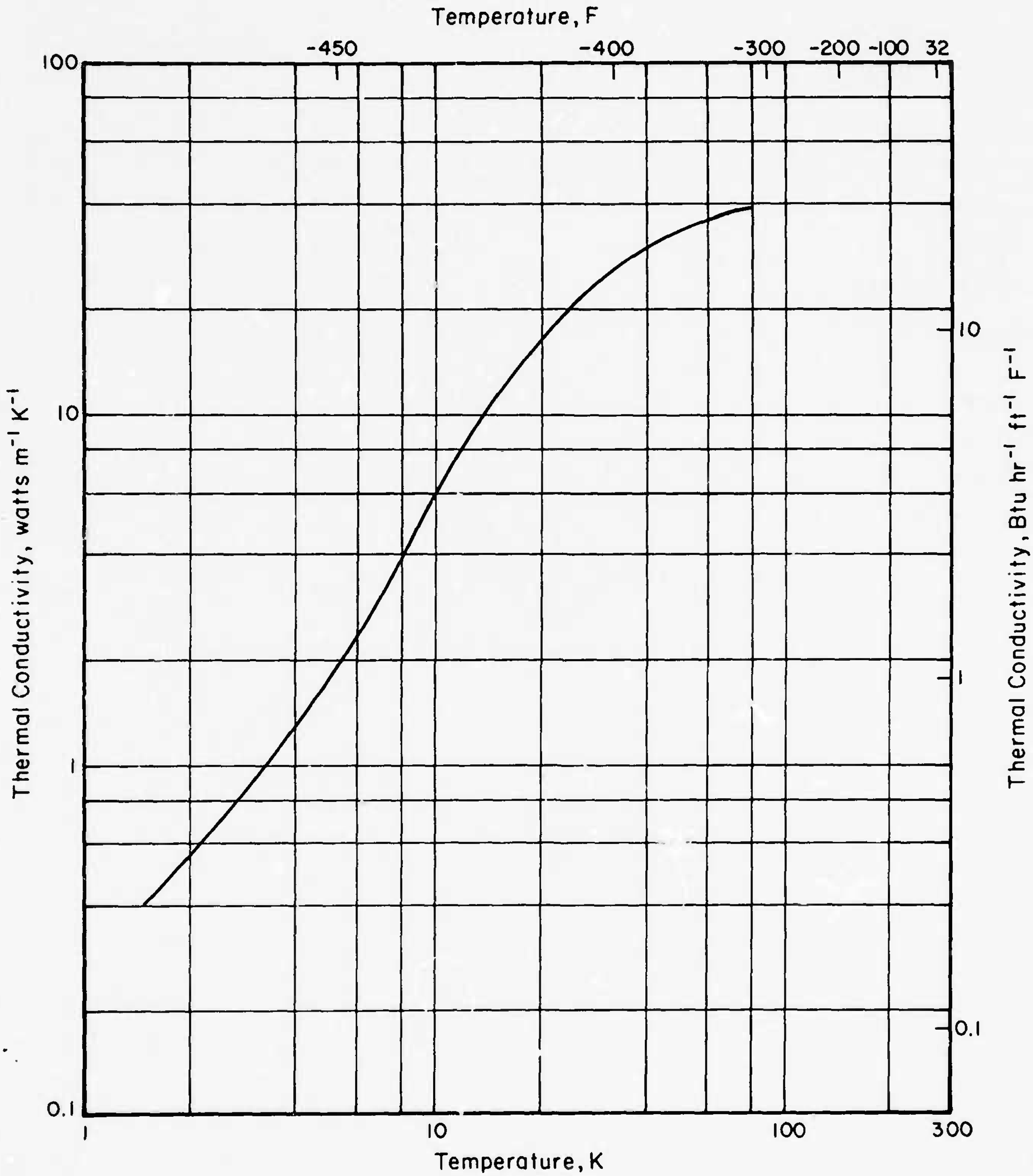

FIGURE 5.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERTURE FOR COPPER ALLOY 90Cu-10Ni

TABLE 5.3.2-ME1

Alloy Designation: 80Cu-20Ni Alloy

Specification: CDA No. 710
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Annealed (assumed)

Testing Temperature. K (F)		297 (75)	220 (-60)	173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	299 (43.3)	332 (48.2)	363 (52.6)	387 (56.1)	469 (68.0)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	56	57	57	55	56	
	Min						
RA, percent	Avg	70.0	68.5	66.0	63.0	57.0	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96688

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TABLE 5.3.2-ME2

Alloy Designation:	80Cu-20Ni Alloy (Weld Metal)
Specification:	CDA No. 710
Form:	Plate-MIG welded, 80Cu-20Ni Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate tested as welded

Testing Temperature, K (F)		297 (75)	173 (-150)	123 (-240)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg		92 (68)	92.9 (68.5)			
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation –							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 96683

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 5.3.2-TR1

Alloy Designation:	80Cu-20Ni Alloy
Specification:	CDA No. 710
Form:	
Dimension:	
Condition:	Annealed

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}							10.20		4.10		0.950	
Btu hr^{-1} ft^{-1} F^{-1}								(590)		(2.37)		(0.549)
No. of Spec.							2		2		2	
References: 90170, 96875												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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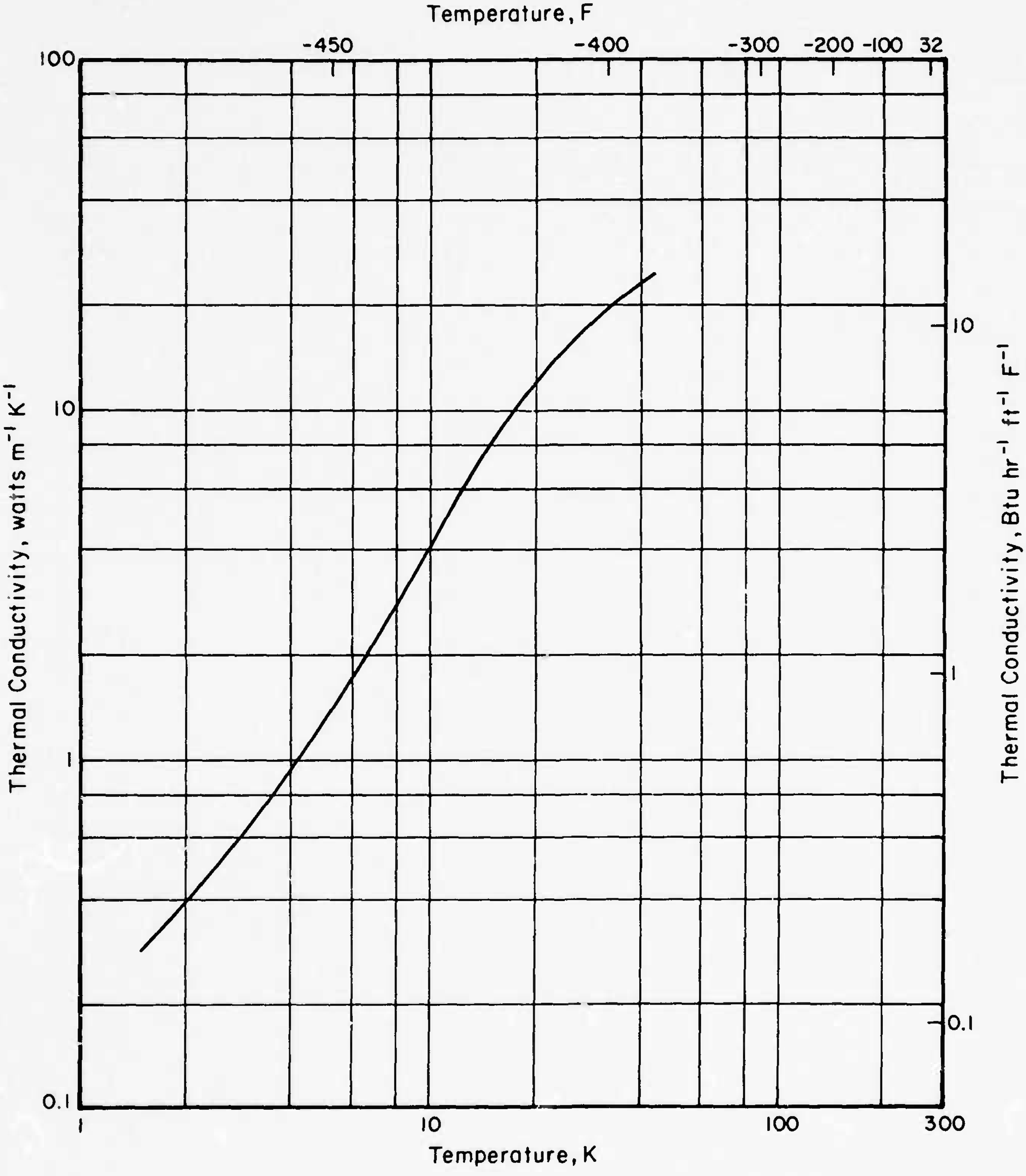

FIGURE 5.3.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 80Cu-20Ni

TABLE 5.3.3-ME0.1

Alloy Designation:	70Cu-30Ni Alloy
Specification:	CDA No. 715
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Annealed (assumed)

Testing Temperature, K (F)		297 (75)	220 (-60)	173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	288 (41.8)	321 (46.6)	348 (50.4)	382 (55.4)	435 (63.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	57	59	60	63	70	
	Min						
RA, percent	Avg	80.0	79.5	77.5	76.5	76.0	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96688

TABLE 5.3.3-ME0.2

Alloy Designation:	70Cu-30Ni Alloy (Weld Metal)
Specification:	CDA No. 715
Form:	Plate-MIG welded, 70Cu-30Ni Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate tested as welded

Testing Temperature, K (F)		297 (75)	173 (-150)	123 (-240)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg		104 (77)	110 (81)			
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 96683

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 5.3.3-TR1

Alloy Designation: 70Cu-30Ni

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}				9.32	4.22	1.1
Btu hr^{-1} ft^{-1} F^{-1}				(5.39)	(2.44)	(0.64)
No. of Spec.				1	1	1
References: 96888						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.222	-0.248	-0.252	-0.252	-0.252
No. of Spec.	1	1	1	1	1	1
References: 90336						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	38.4×10^{-8}	36.9×10^{-8}	36.6×10^{-8}	36.5×10^{-8}	36.4×10^{-8}	36.4×10^{-8}
Ohm circular mil ft^{-1}	(231)	(222)	(220)	(220)	(219)	(219)
No. of Spec.	1	1	1	1	1	1
References: 79561						
Magnetothermal Conductivity(1)						

(1) The application of magnetic fields up to 8 tesla produced no detectable effect on the thermal conductivity.

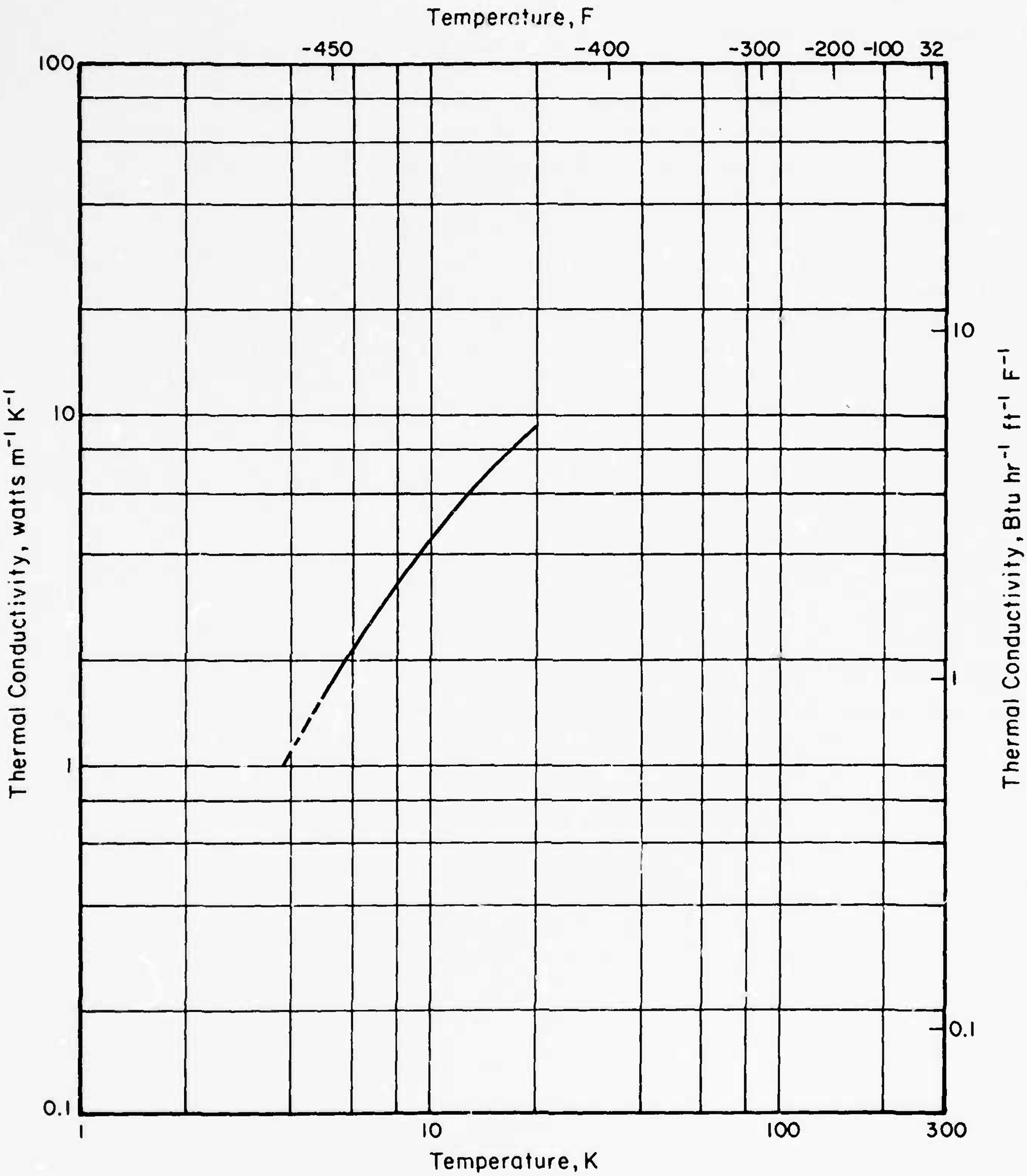

FIGURE 5.3.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

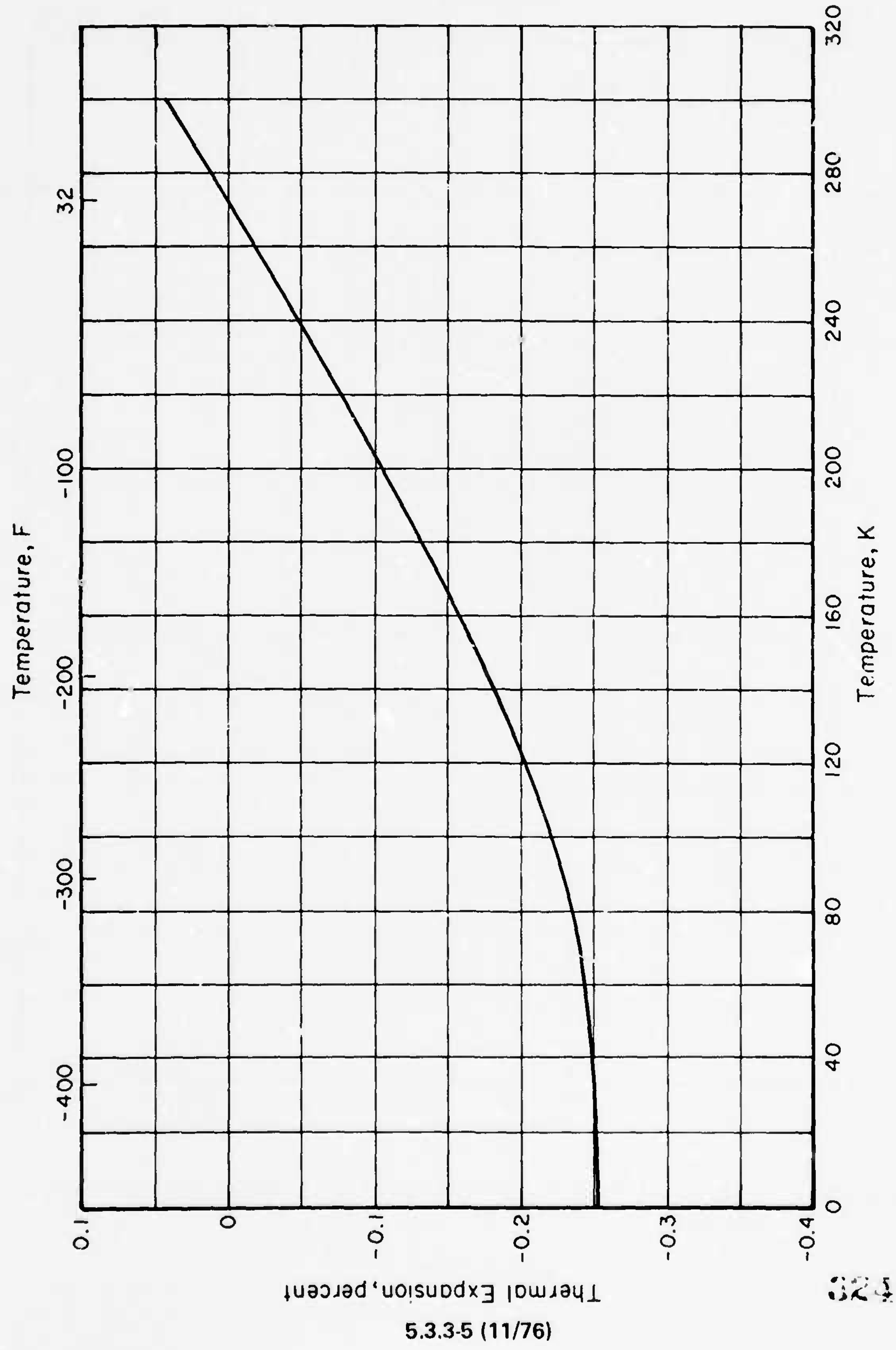

FIGURE 5.3.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

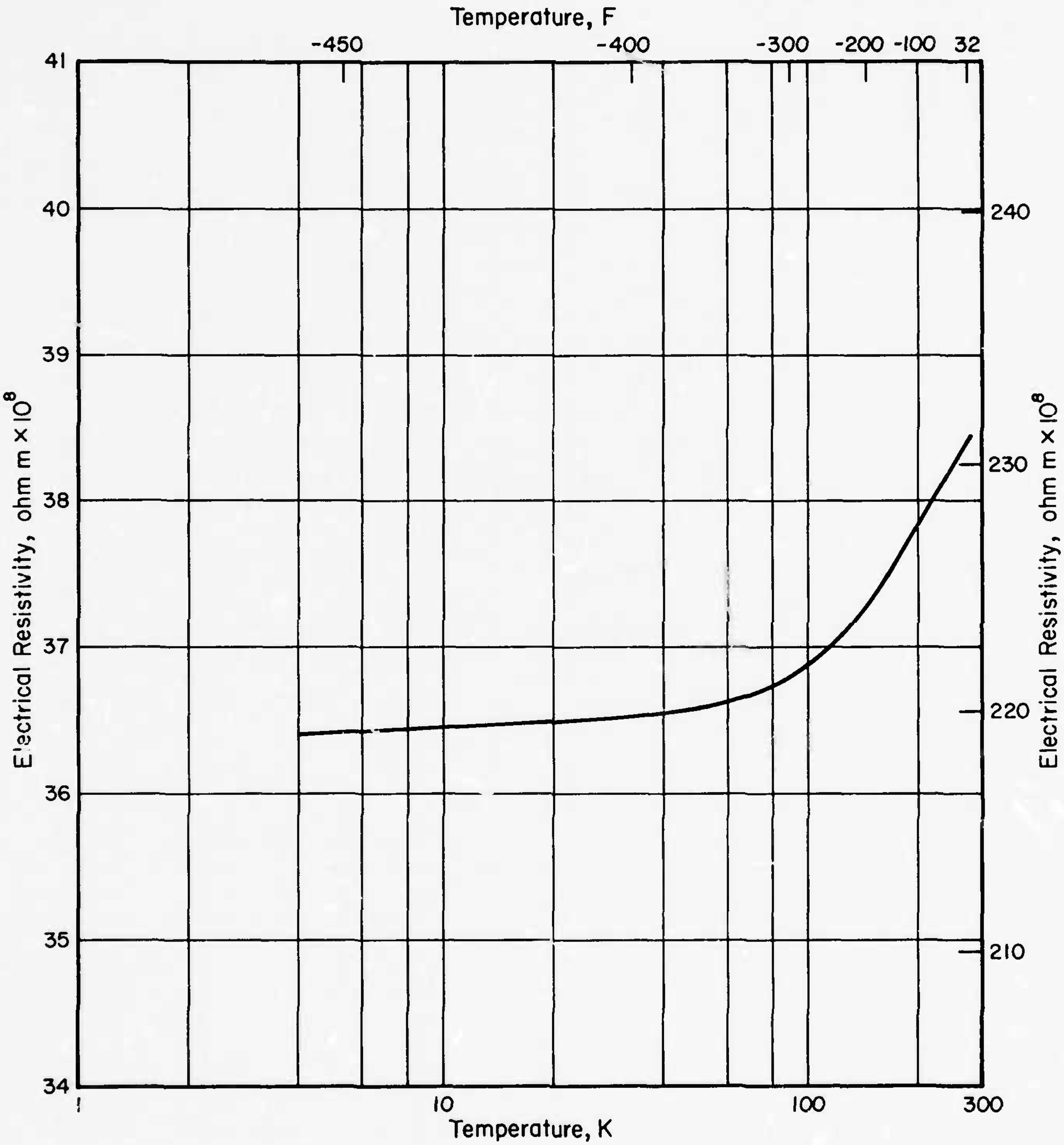

FIGURE 5.3.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

TABLE 5.4.2-ME0.1

Alloy Designation:	Cu-Be (1.8-2.0) Alloy
Specification:	CDA No. 172
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	AT (600 F, 3 hr, AC)

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)	20 (-423)	
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	648 (94)	689 (100)		779 (113)	1076 (156)	
Loading frequency 30 Hz (a)						
with R = -1 and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)	414 (60)	469 (68)		517 (75)	724 (105)	
Loading frequency 30 Hz (a)						
with R = -1 and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 45001

(a) Frequency = 58Hz for tests at 20 K

TABLE 5.5.1-TR1

Alloy Designation: 95Cu-5Sn Alloy (Phosphor Bronze A)

Specification: CDA No. 518
Form:
Dimension:
Condition: Annealed except as noted

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal (1)						
Percent	0	-0.252	-0.291	-0.297	-0.297	-0.297
No. of Spec.	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	10.48×10^{-8}	9.08×10^{-8}	8.70×10^{-8}	8.58×10^{-8}	8.58×10^{-8}	8.59×10^{-8}
Ohm circular mil ft^{-1}	(63.0)	(54.6)	(52.3)	(51.6)	(51.6)	(51.7)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) Spring, cold drawn 85%

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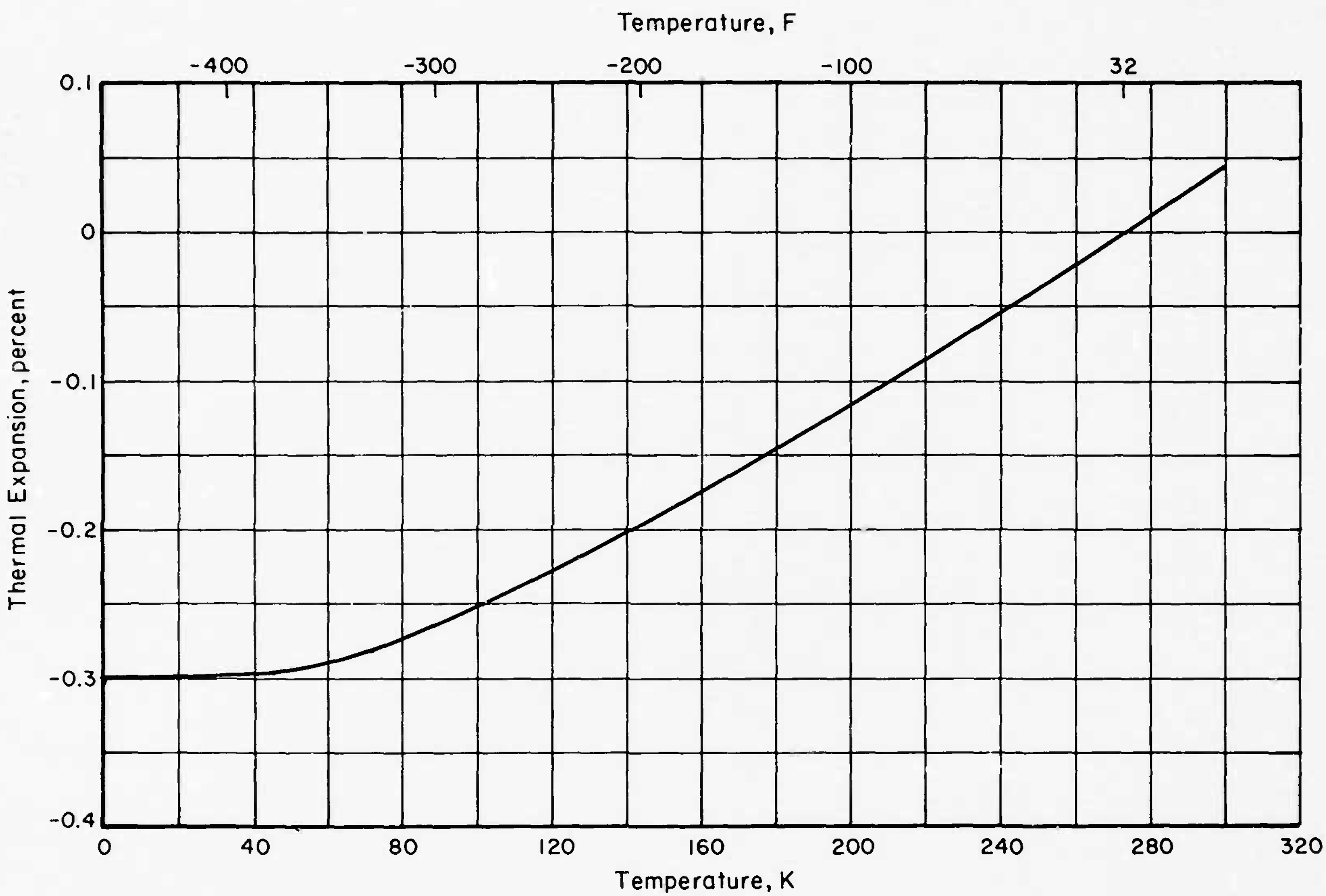

FIGURE 5.5.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY 95Cu-5Sn

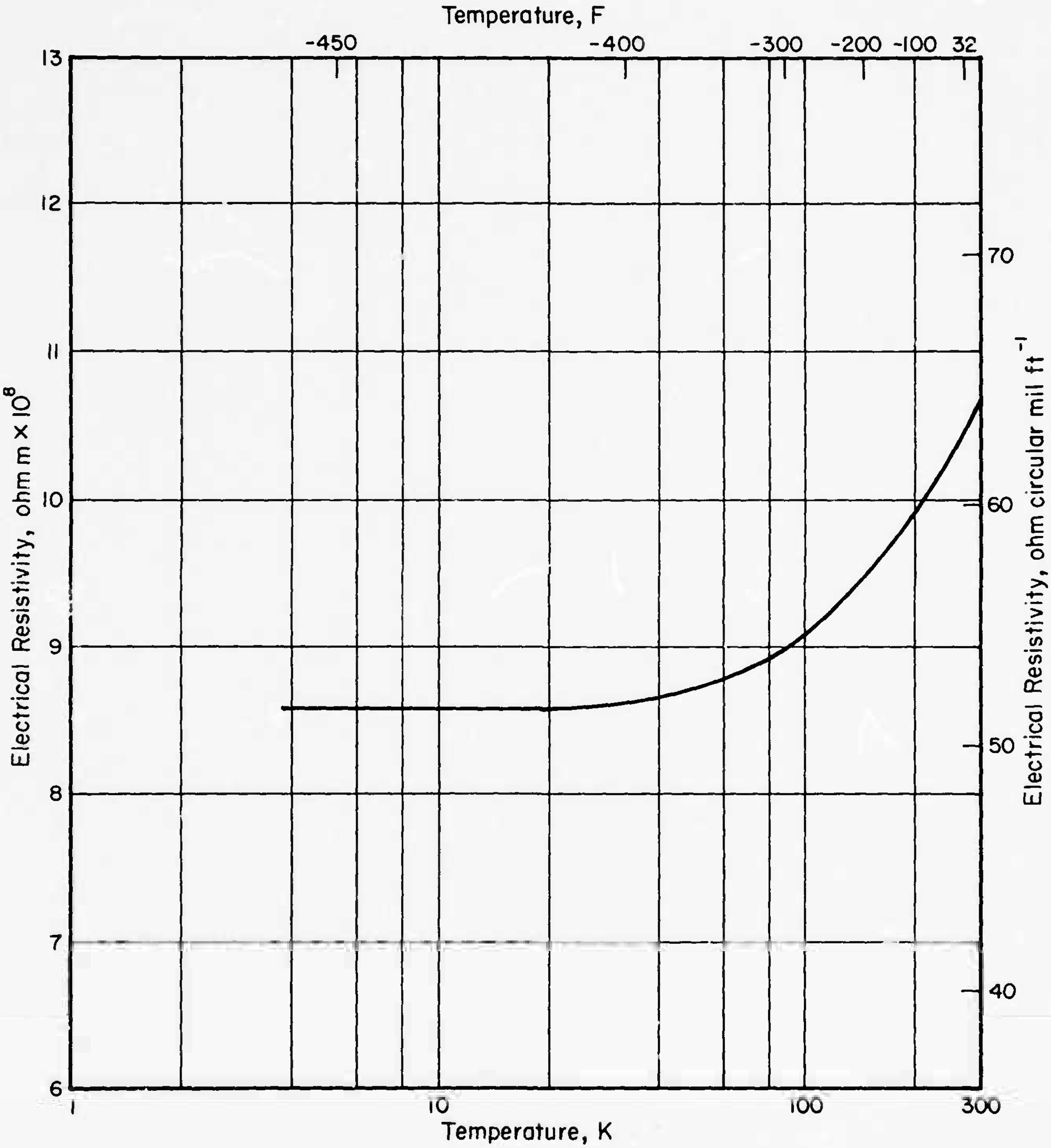

FIGURE 5.5.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 95Cu-5Sn

TABLE 5.5.2-TR1

Alloy Designation: 92Cu-8Sn Alloy C52100

Specification: CDA-521
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}					1.08	0.07
Btu lb^{-1} F^{-1}					(0.000258)	(0.0000167)
No. of Spec.					1	1
References: 94206						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

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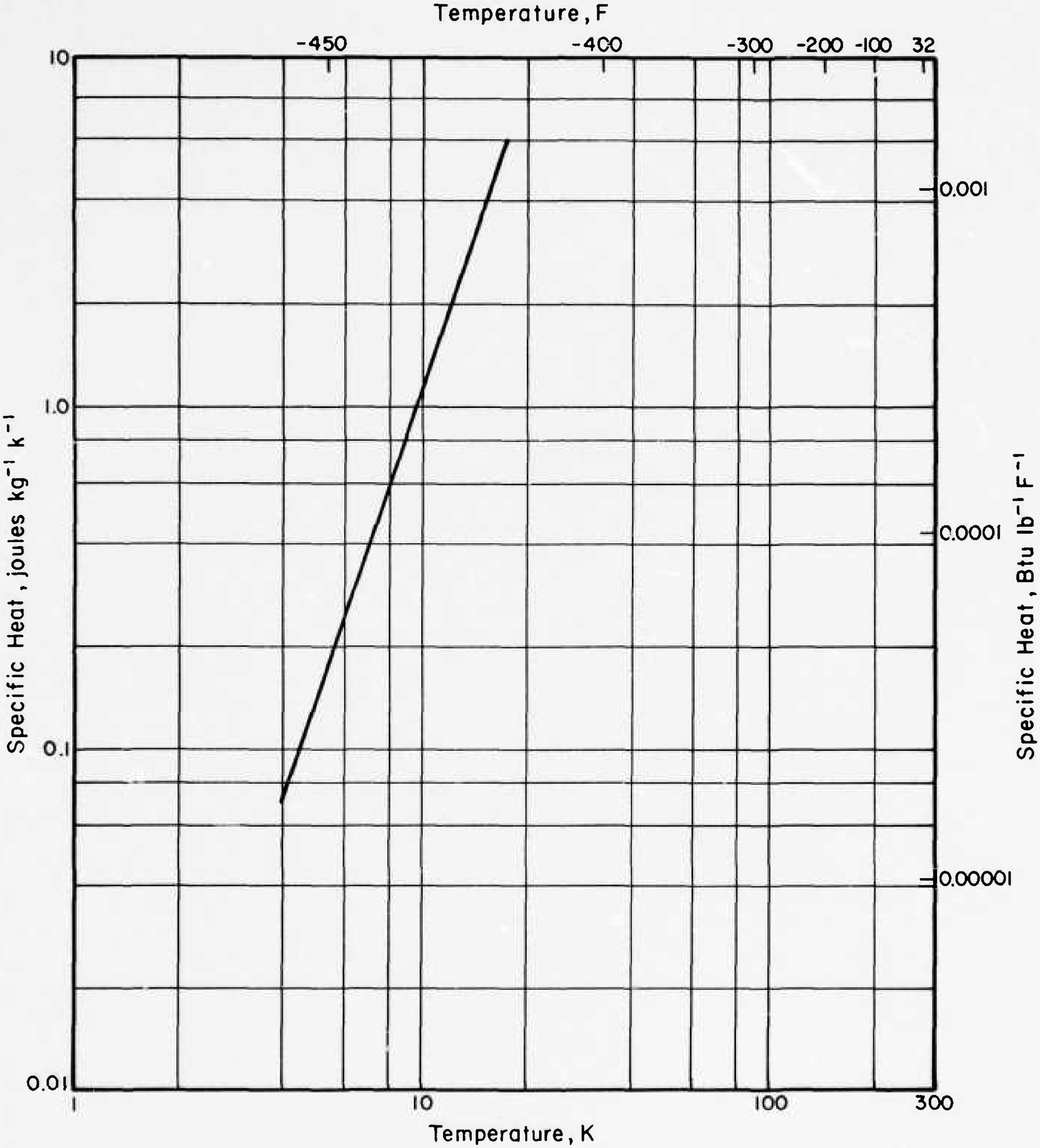

FIGURE 5.5.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 92Cu-8Sn

TABLE 5.5.3-TR1

Alloy Designation:	90Cu-10Sn Alloy
Specification:	CDA No. 524
Form:	
Dimension:	
Condition:	

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.263	-0.314	-0.330	-0.332	-0.333
No. of Spec.	1	1	1	1	1	1
References: 94206						
Specific Heat						
Joules kg^{-1} K^{-1}					1.2	
Btu lb^{-1} F^{-1}					(2.86×10^{-4})	
No. of Spec.					1	
References: 94206						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

(1) 89Cu-11Sn, as cast

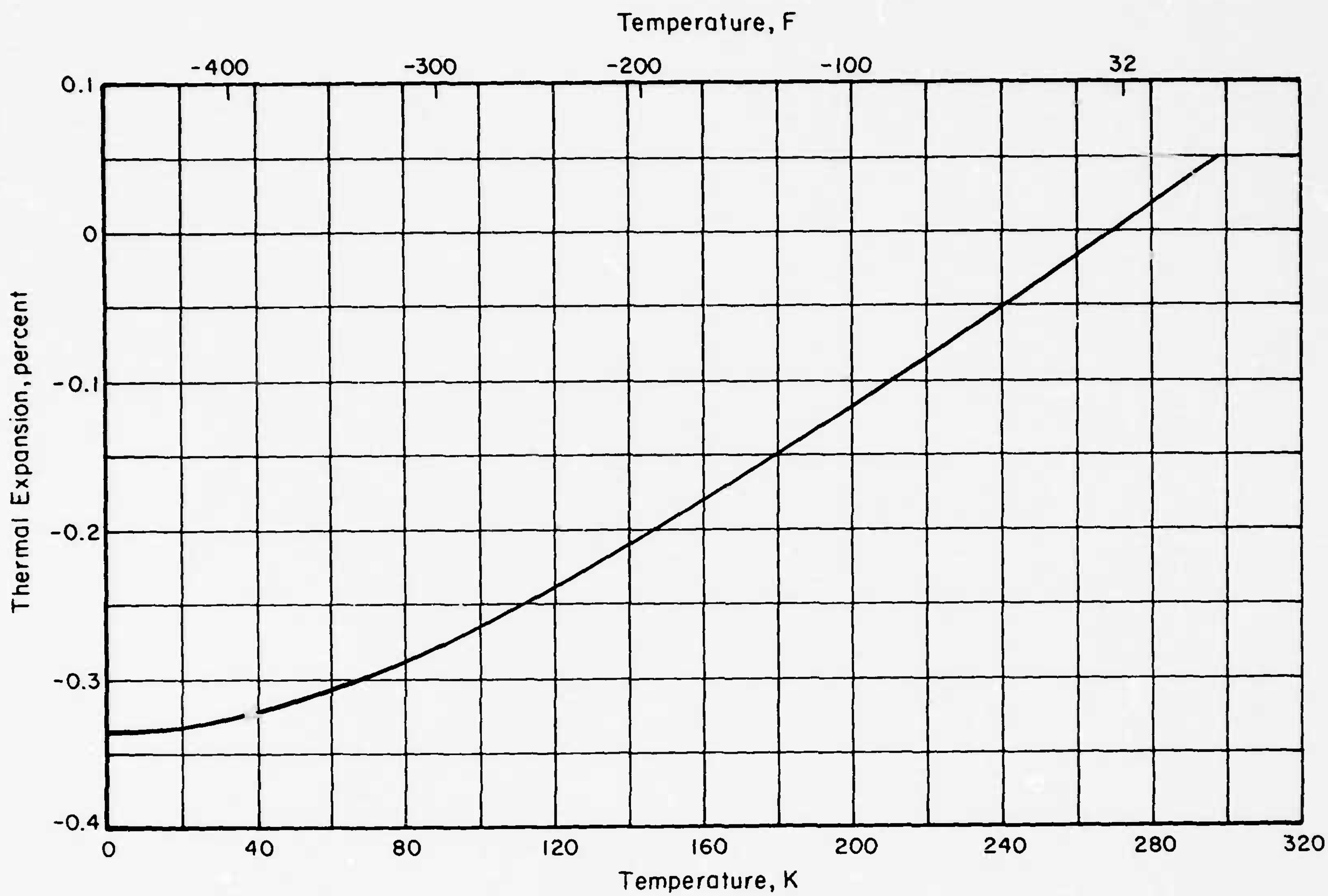

FIGURE 5.5.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Sn

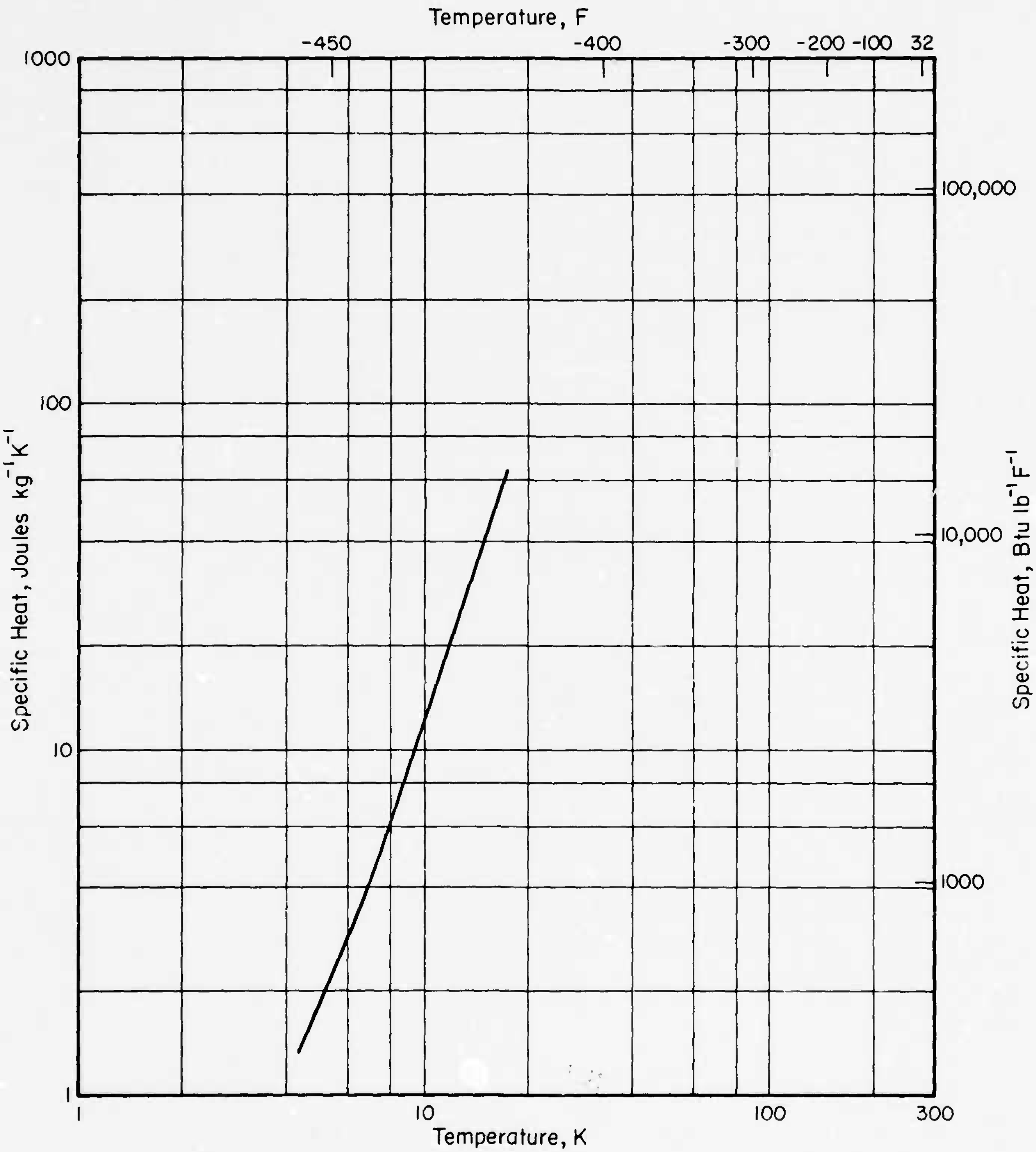

FIGURE 5.5.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Sn

TABLE 5.7.1-ME1

Alloy Designation: Cu-Cr-Cd/PHT (PD-135)

Specification:
Form: Extrusion
Thickness, cm (in.): 1.59 (0.625) to 2.54 (1.000)
Condition: Extruded from 20.3 cm (8-inch) billet at 1227 K (1750 F), Precipitation hardened 1 hr at 866 K (1100 F)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	350 (50.8)	478 (69.3)	523 (75.8)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	243 (35.3)	263 (38.1)	255 (37.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	32.0	40.2	59.8			
	Min						
RA, percent	Avg	73.4	71.2	67.8			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	436 (63.3)	622 (90.2)	694 (100.7)			
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208G

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TABLE 5.7.1-TR1

Alloy Designation: Cu-Cr-Cd (PD-135)

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.249				
No. of Spec.	1	1				
References: 95168						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

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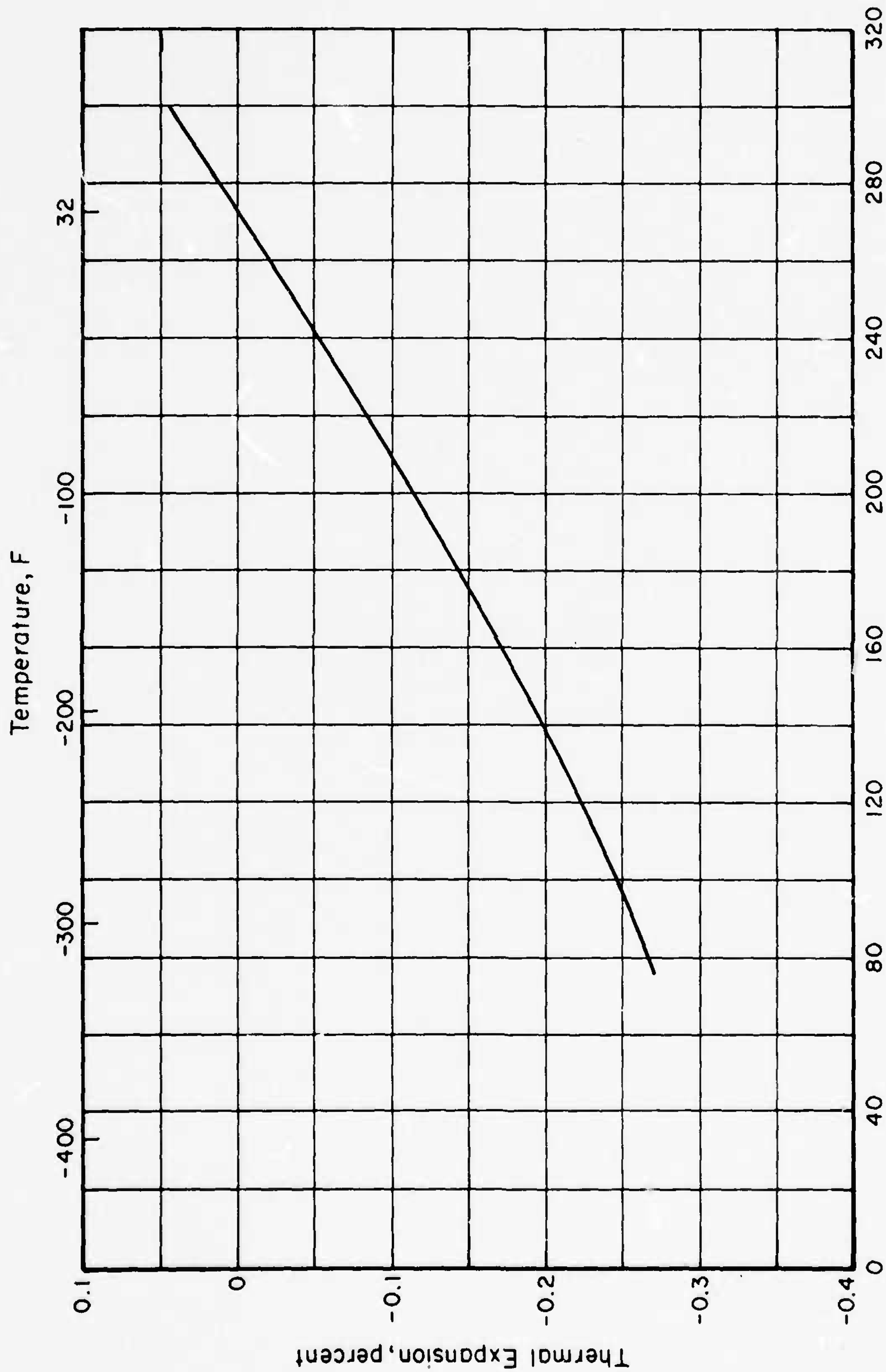

FIGURE 5.7.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Cu-Cr-Cd (PD-135) ALLOY

TABLE 5.9.1-ME1

Alloy Designation:	Cu-Al Alloy (Aluminum Bronze D)
Specification:	CDA No. 614
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	574 (83.2)	617 (89.5)		729 (106.8)	872 (126.4)	927 (134.5)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	410 (59.4)	447 (64.8)		479 (69.5)	556 (80.6)	568 (82.4)
	Min						
Std. Deviation							
Elong, percent	Avg	40	45		52	48	52
	Min						
RA, percent	Avg	66	71		64	58	59
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
E, GN/m^2 (10^6 psi)	Avg	109 (15.8)	111 (16.1)		112 (16.3)	112 (16.3)	112 (16.3)
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	845 (122.5)	919 (133.3)		1021 (148.1)	1202 (174.3)	1109 (160.8)
K_t = 5.0	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90375

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TABLE 5.9.1-ME2

Alloy Designation:	Cu-Al Alloy (Aluminum Bronze D)
Specification:	CDA No. 614
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	149 (110)	136 (100)		98 (72)	89 (66)	
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 90375

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 5.9.1-TR1

Alloy Designation:	Aluminum Bronze											
Specification:												
Form:												
Dimension:												
Condition:	Annealed											
Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}(1)											2.10	
Btu hr^{-1} ft^{-1} F^{-1}												(1.21)
No. of Spec.											3	
References: 90170												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent (2)	0		0.240		-0.277		-0.282		-0.283			
No. of Spec.	1		1		1		1		1			
References: 74405												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m(3)	18.4×10^{-8}		16.2×10^{-8}		15.8×10^{-8}		15.6×10^{-8}		15.7×10^{-8}		15.7×10^{-8}	
Ohm circular mil ft^{-1}		(111)		(97.4)		(95.0)		(93.8)		(94.4)		(94.4)
Ohm m(4)	16.2×10^{-8}		14.2×10^{-8}		13.8×10^{-8}		13.8×10^{-8}		13.8×10^{-8}		12.9×10^{-8}	
Ohm circular mil ft^{-1}		(97.4)		(85.4)		(83.0)		(83.0)		(83.0)		(83.6)
No. of Spec. (No. of Heats)	2		2		2		2		2		2	
References: 79561												

(1) Cu + 4.5-6.1Al.
(2) 90.95Cu, 6.57Al, 2.13Fe.
(3) 81Cu, 9.95Al, 5.20Ni, 3.35Fe, 0.3Mn
(4) 91Cu, 6.57Al, 2.13Fe

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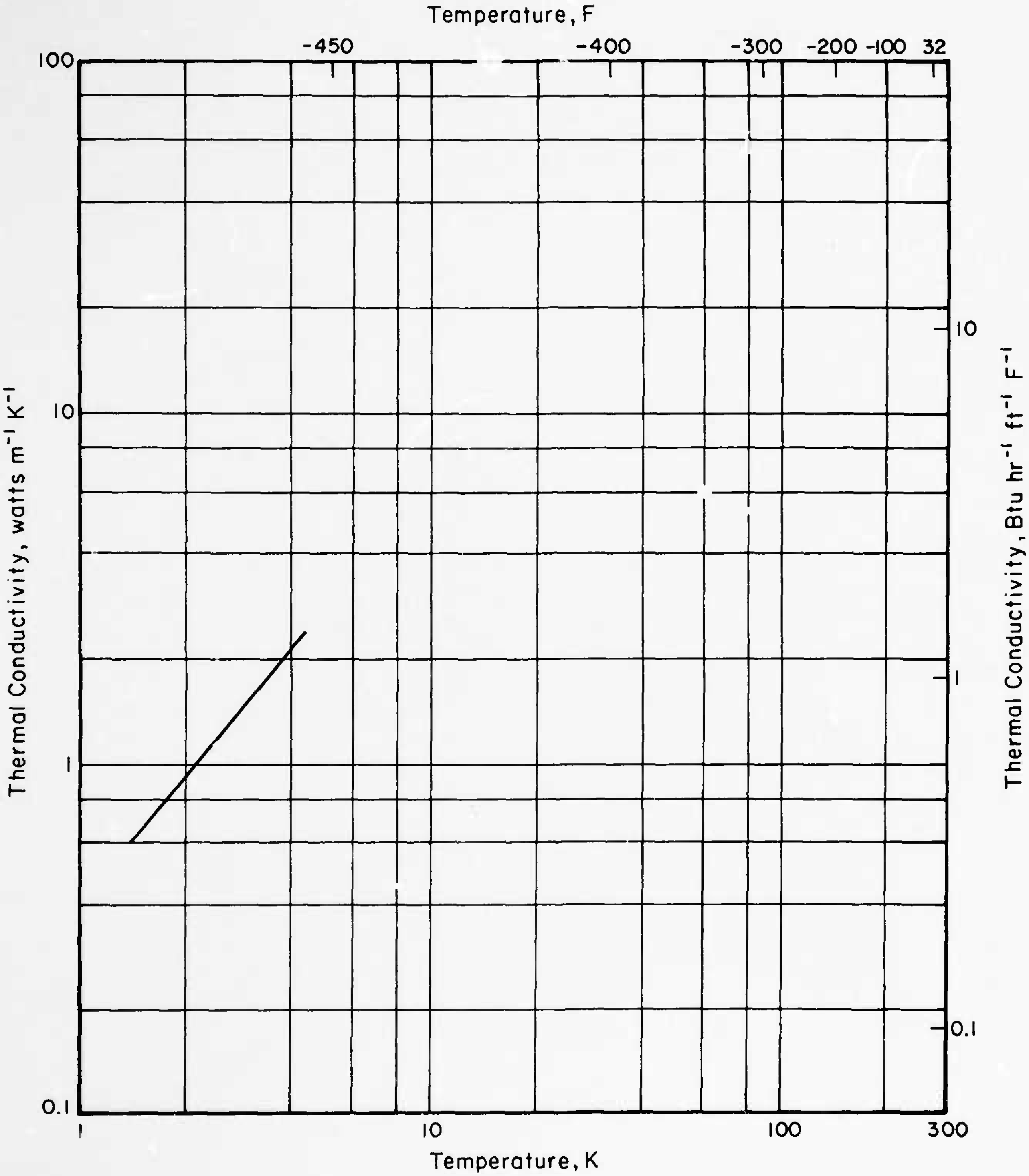

FIGURE 5.9.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY ALUMINUM BRONZE (Cu + 4.0-7.0Al)

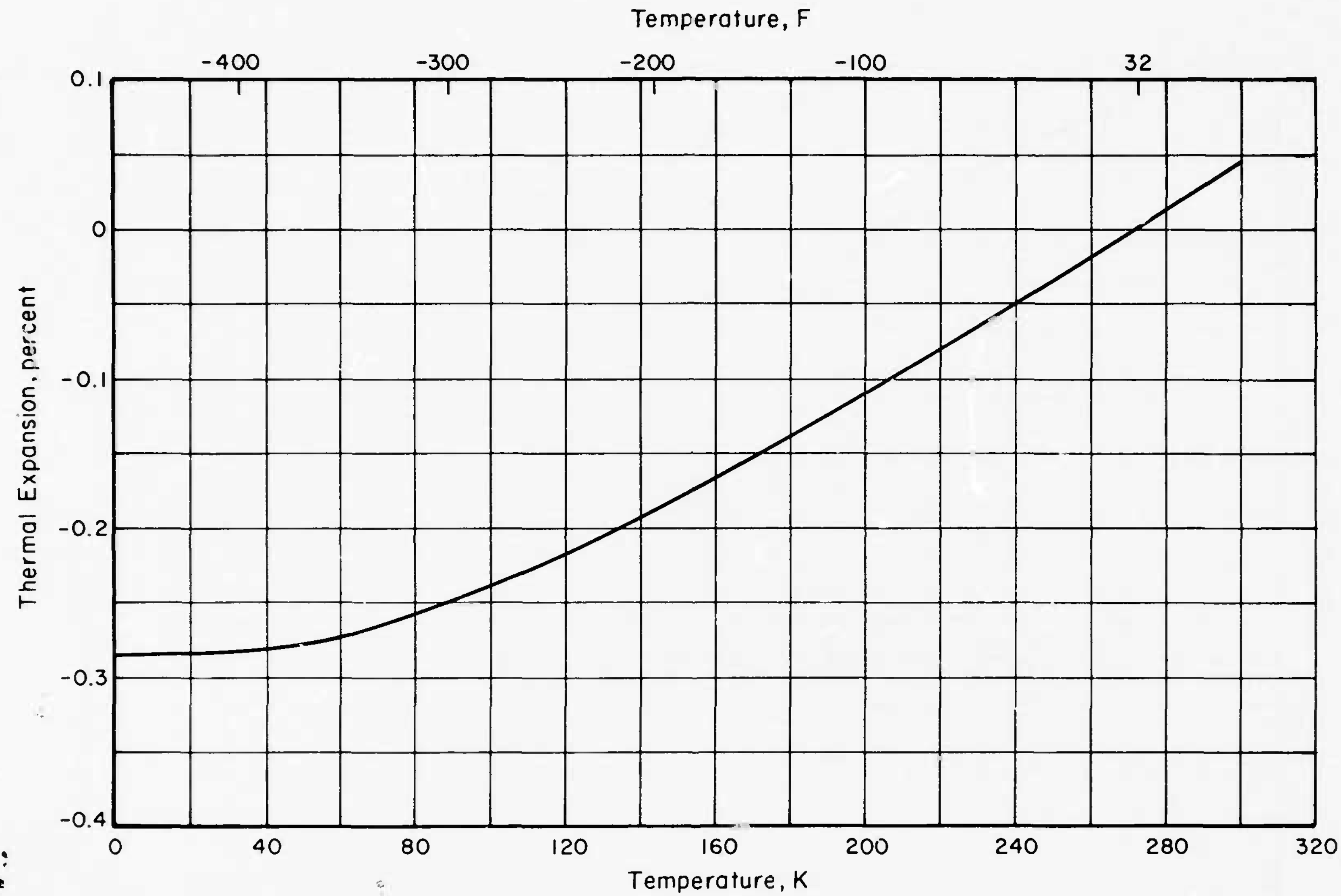

FIGURE 5.9.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY ALUMINUM BRONZE (90.95Cu, 6.57Al, 2.13Fe)

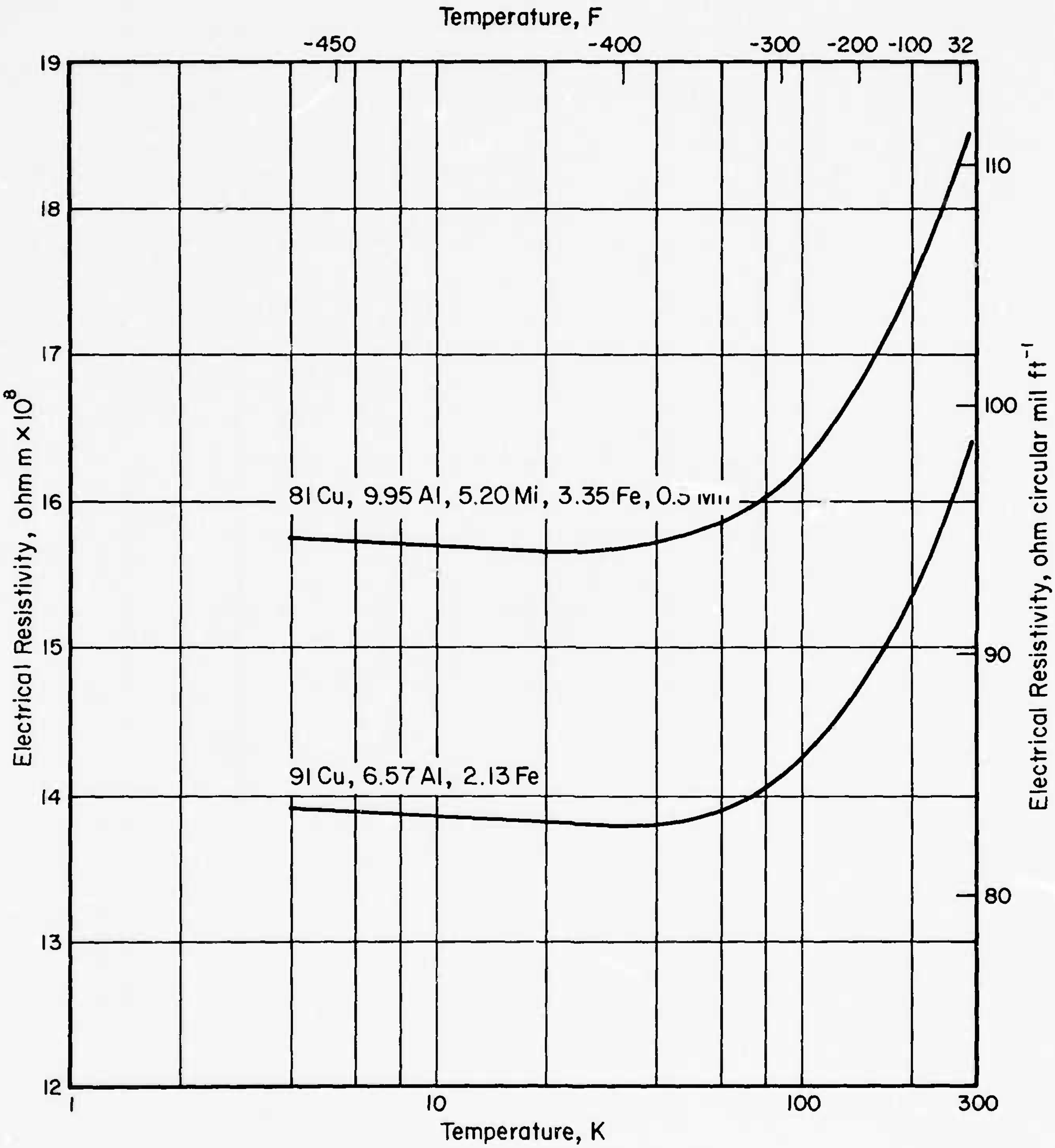

FIGURE 5.9.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY ALUMINUM BRONZE

INDEX TO MATERIAL CODES FOR SECTION 6.0

NICKEL AND NICKEL ALLOYS

MATERIALS	MATERIAL CODE
K MONEL (K-500)	6.1.1
INCONEL 600	6.2.1
INCONEL X-750	6.2.2
INCONEL 718	6.2.3
INCONEL 706	6.2.4
INVAR 36	6.3.1
Ni-SPAN C	6.3.2
INCO LEA	6.3.3
NICKEL	6.4.1
"A" NICKEL	6.4.2

TABLE 6.1.1-ME3

Alloy Designation:	K Monel (K-500) Nickel-Base Alloy
Specification:	QQ-N-286
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 – 0.125)
Condition:	Aged 867 K (1100 F) 16 hr + controlled cooling cycle

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 90 rms						
S_N at 10^5 cycles, MN/m^2(ksi)	517 (75)		607 (88)	634 (92)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.50		0.50	0.47		
S_N at 10^6 cycles, MN/m^2(ksi)	379 (55)		393 (57)	476 (69)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.37		0.32	0.36		
S_N at 10^7 cycles, MN/m^2(ksi)	345 (50)		352 (51)			
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.34		0.29			
Fatigue, Flexural Loading, Surface Finish 16 rms						
S_N at 10^5 cycles, MN/m^2(ksi)	586 (85)		662 (96)	745 (108)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.56		0.53	0.55		
S_N at 10^6 cycles, MN/m^2(ksi)	379 (55)		469 (68)	579 (84)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.36		0.38	0.43		
S_N at 10^7 cycles, MN/m^2(ksi)	324 (47)		448 (65)			
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.31		0.36			

References: 33417

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TABLE 6.1.1-ME3.1

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297 (75)		195 (-108)		144 (-200)		77 (-320)		20 (-423)		
Tension, Longitudinal												
TUS, MN/m² (ksi)	Avg	656	(95.1)	72.81	(105.6)	789.5	(114.5)	919.8	(13.34)	1048	(152.0)	
	Min											
Std. Deviation												
TYS, MN/m² (ksi)	Avg	314	(45.6)	349	(50.6)	390	(56.6)	448	(65.0)	515	(74.7)	
	Min											
Std. Deviation												
Elong, percent	Avg	38.8		40.0		41.0		48.0		43.3		
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)	
E, GN/m² (10⁶ psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m² (ksi)	Avg	623	(90.3)	690.2	(100.1)	754.3	(109.4)	832.9	(120.8)	897.7	(130.3)	
K_t = 10	Min											
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)	
NTS, MN/m² (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m² (ksi)	Avg	656	(95.2)	737.1	(106.9)	992.9	(144.0)	913.6	(132.5)	105.5	(153.0)	
	Min											
Std. Deviation												
TYS, MN/m² (ksi)	Avg	316	(45.8)	360	(52.2)	395	(57.3)	439	(63.6)	574	(83.2)	
	Min											
Std. Deviation												
Elong, percent	Avg	36.5		40.5		40.5		44.7		42.5		
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)	
E, GN/m² (10⁶ psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m² (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m² (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 90181

TABLE 6.1.1-ME3.2

Alloy Designation:	K Monel (K-500) Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, K-Monel filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	652 (94.6)	729.5 (105.8)	788.1 (114.3)	941.8 (136.6)	1106 (160.4)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	328 (47.5)	376 (54.5)	399 (57.9)	481 (69.8)	610 (88.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	32.2	35.7	35.5	41.0	36.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90181

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TABLE 6.1.1-ME3.3

Alloy Designation: K Monel (K-500) Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, K-Monel filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed sheet, welded, then age hardened and tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1049 (152.1)	1114 (161.5)	1138 (165.0)	1252 (181.6)	1364 (197.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	759.1 (110.1)	828.8 (120.2)	841.9 (122.1)	924.6 (134.1)	1007 (146.1)	
	Min						
Std. Deviation							
Elong, percent	Avg	19.0	21.2	20.7	26.0	24.3	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90181

TABLE 6.1.1-ME3.4

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Cold rolled, ½ hard and age hardened

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1250 (182)				1640 (238)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1120 (163)				1430 (208)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.5				15.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1				1	
E, GN/m^2 (10^6 psi)	Avg	180 (26)				219 (30)	
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49048

TABLE 6.1.1-ME3.5

Alloy Designation:	K Monel (K-500) Nickel-Base Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Cold rolled, ½ hard and age hardened

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)	20 (-423)	
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency 30[a] Hz with R = -1 and K_t = 1 No. of S-N Curves (No. of Heats)	620 (90)	690 (100)		720 (105)	979 (142)	
Ratio S_N/TUS at 10^5 cycles	380 (55)	460 (67)		480 (69)	696 (101)	
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency 30[a] Hz with R = -1 and K_t = 1 No. of S-N Curves (No. of Heats)	380 (55)	460 (67)		480 (69)	696 (101)	
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency 30[a] Hz with R = -1 and K_t = 3.1 No. of S-N Curves (No. of Heats)	460 (66)	510 (74)		570 (82)	660 (95)	
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency 30[a] Hz with R = -1 and K_t = 3.1 No. of S-N Curves (No. of Heats)	270 (39)	300 (43)		330 (48)	330 (48)	
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 49048

(a) Frequency = 58 Hz for tests at 20 K (-423 F)

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TABLE 6.1.1-ME3.6

Alloy Designation: K Monel (K-500) Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, K-Monel filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Age-hardened sheet, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	683 (99.0)	757.7 (109.9)	819.1 (118.8)	921.8 (133.7)	1096 (158.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	432 (62.7)	516 (74.9)	585 (84.9)	643 (93.2)	743.9 (107.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.2	8.7	8.7	9.5	10.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90181

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TABLE 6.1.1-ME4

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286A
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Aged 867 K (1100 F) 21 hr, 811 K (1000 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1082 (157)	1225 (178)	1295 (188)	1417 (206)		
	Min	1048 (152)	1214 (176)	1255 (182)	1379 (200)		
Std. Deviation		41.7 (6.05)					
TYS, MN/m^2 (ksi)	Avg	703 (102)	893 (130)	865 (125)	939 (136)		
	Min	634 (92)	887 (129)	800 (116)	862 (125)		
Std. Deviation		65.2 (9.46)					
Elong, percent	Avg	28	28.6	32	36.4		
	Min	24	27.3	28	33.8		
RA, percent	Avg	53.7	54.3	54.3	52.4		
	Min	51	54.2	54.3	52.1		
No. of Spec. (No. of Heats)		13 (3)	3 (1)	8 (2)	5 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 54986, 64373, 83417

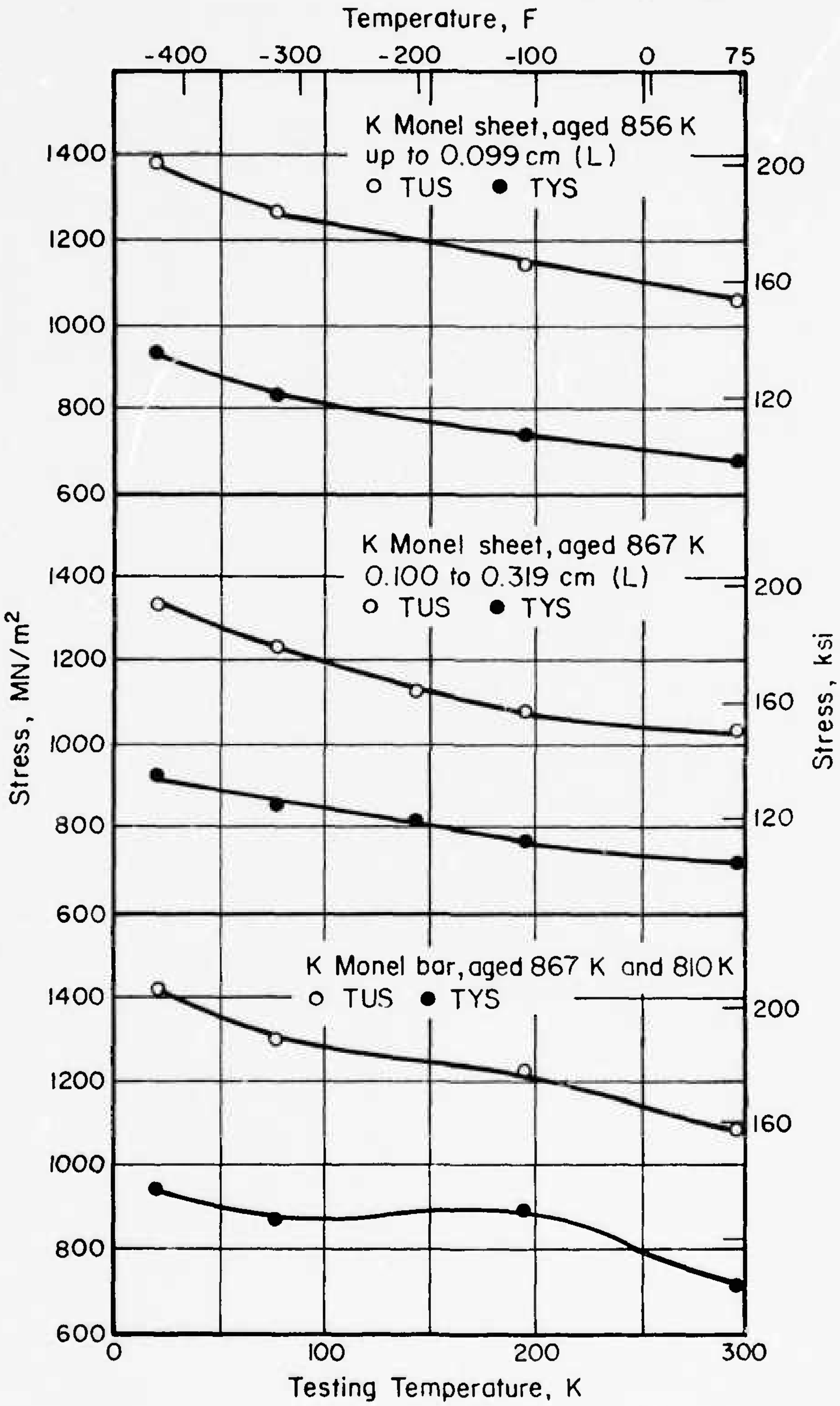

FIGURE 6.1.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF K MONEL (K-500)

TABLE 6.1.1-TR1

Alloy Designation: K-Monel Nickel Alloy

Specification:
Form:
Dimension:
Condition: Age Hardened

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.195	-0.223	-0.223		
No. of Spec.	1	1	1	1		
References: 48134						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

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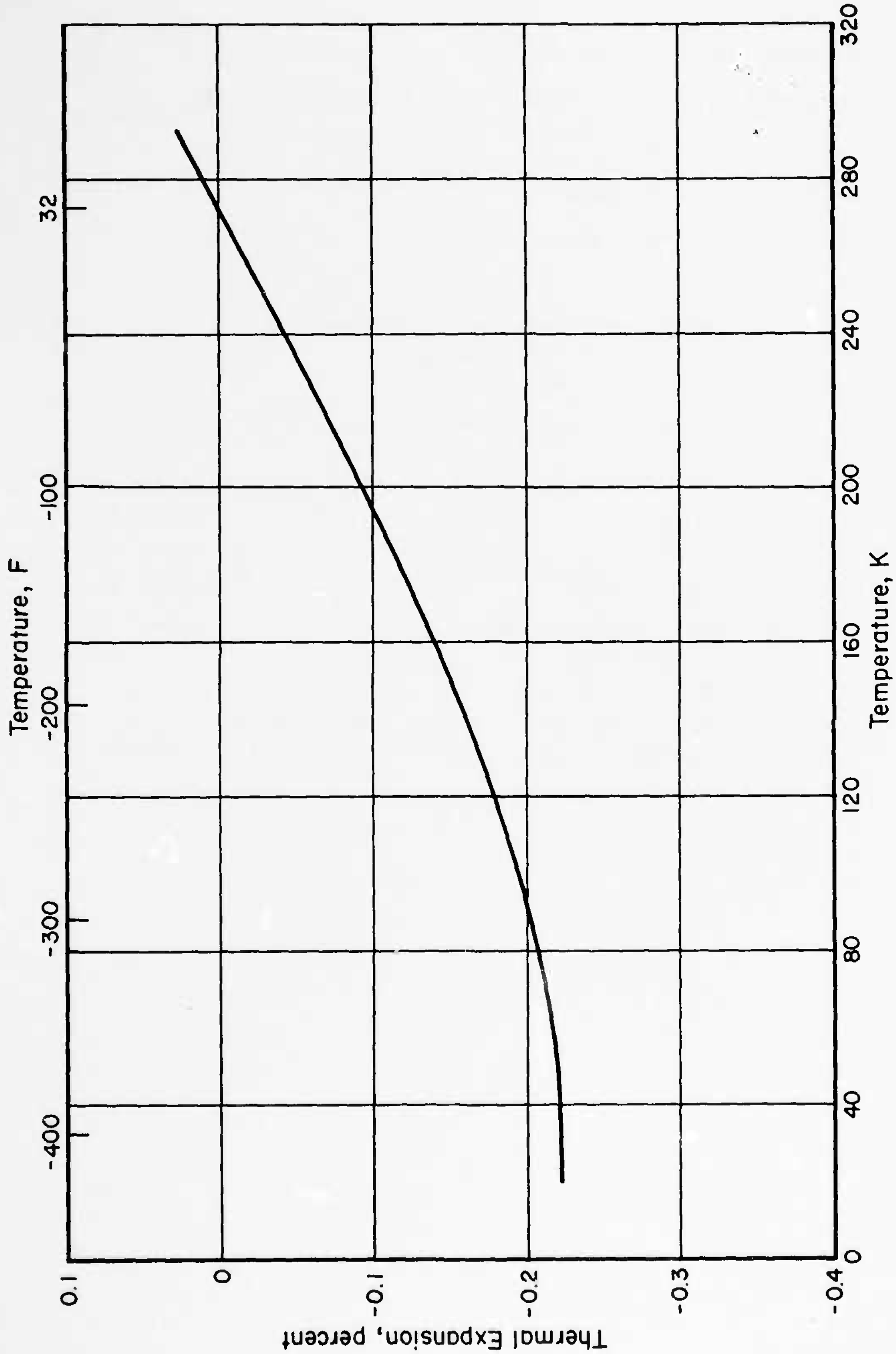

FIGURE 6.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR K-MONEL (AGE-HARDENED)

TABLE 6.1.1-MA1

Alloy Designation:	"K" Monel N05500
Specification:	66.0Ni–29.0Cu–0.9Fe–0.85Mn–1.0Si–0.15O
Form:	Rod
Diameter:	Not given
Condition:	As indicated in table below

Magnetic Permability at Room Temperature
($H = 0.2k_{Oe}$)

Condition	Permeability
Soft*	12.58×10^{-7}
Soft and age hardened**	12.59×10^{-7}
Cold drawn 20 percent	12.58×10^{-7}
Cold drawn 20 percent and age hardened	12.59×10^{-7}
Cold drawn 50 percent	12.58×10^{-7}
Cold drawn 50 percent and age hardened	12.59×10^{-7}

Reference: 90220

* Quenched in water following 45 minutes at 1550 F (1116 K).
** Sixteen hours at 1080 F (855 K), furnace-cooled to 800 F (700 K) at 15deg F per hour and air-cooled.

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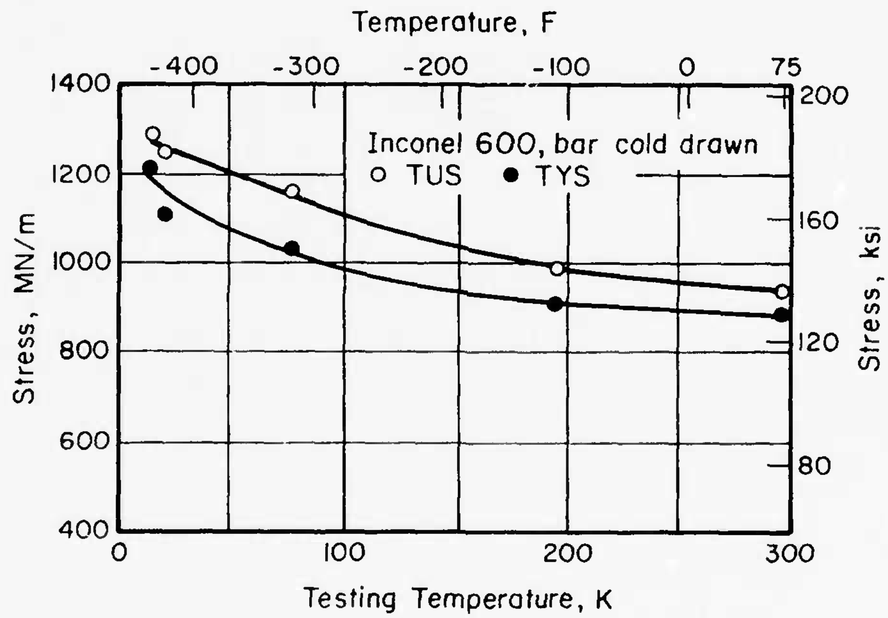

FIGURE 6.2.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF INCONEL 600

Alloy Designation: Inconel 600

Specification:

Form: Rod

Diameter, cm (in.): 0.37 (0.145)

Condition: Solution annealed

Test Temperature: 4.2 K (-452 F)

Measured permeability at room temperature = 12.82 x 10^{-7}

Curie Temperature: 148.5 K (-192 F)

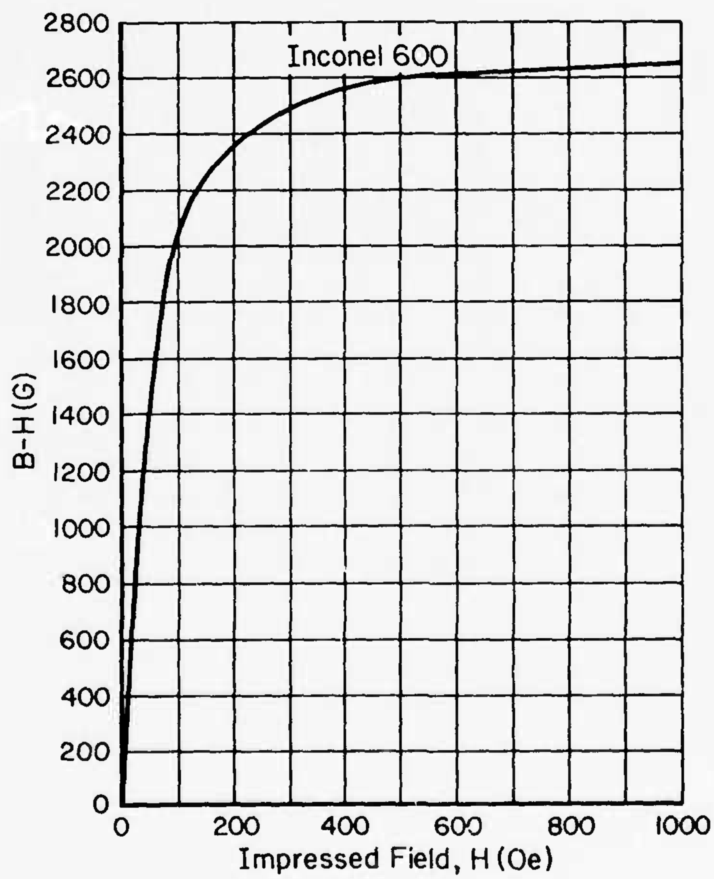

FIGURE 6.2.1-MA1. MAGNETIZATION VALUES FOR INCONEL 600 [96871]

TABLE 6.2.2-ME4.1

Alloy Designation:	Inconel X-750 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded Inconel X-750 filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed sheet welded and tested as welded

Testing Temperature, K (F)		297	(75)	195	(-108)	144	(-200)	77	(-320)	20	(-423)	
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	779.1	(113.0)	857.7	(124.4)	908.0	(131.7)	1033	(149.8)	1107	(160.6)	
	Min											
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	372	(54.0)	405	(58.7)	434	(63.0)	478	(69.3)	510	(74.0)	
	Min											
Std. Deviation												
Elong, percent	Avg	40.8		44.2		44.7		49.7		38.0		
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)	3	(1)	
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
Elong, percent	Avg											
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 58060

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TABLE 6.2.2-ME4.2

Alloy Designation:	Inconel X-750 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, Inconel X-750 filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed sheet, welded, weldment aged 20 hr @ 1300 F, then tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1249 (187.1)	1347 (195.4)	915.6 (204.2)	1542 (223.7)	1661 (240.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	864.6 (125.4)	915.6 (132.8)	940.4 (136.4)	946.7 (137.3)	1017 (147.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	22.5	24.3	23.5	29.7	28.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58060

TABLE 6.2.2-ME4.3

Alloy Designation:	Inconel X-750 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, Inconel X-750 filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed Sheet, aged 20 hr @ 1300 F, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	825.3 (119.7)	928.0 (134.6)	988.7 (143.4)	1087 (157.7)	1220 (176.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	498 (72.3)	592 (85.9)	645 (93.5)	678 (98.3)	793.6 (115.1)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.5	10.2	10.7	14.0	14.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58060

TABLE 6.2.2-ME4.4

Alloy Designation:	Inconel X-750 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, Inco weld 69 filler alloy
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Vacuum annealed 1325 K (1925 F) 30 min + rapid FC with N_2 gas; heated in air 978 K (1300 F) 20 hr, AC, after welding, then tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1172 (170.0)			1438 (208.5)		
	Min	1165 (168.9)			1421 (206.1)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	768.8 (111.5)			850.8 (123.4)		
	Min	768.1 (111.4)			846.7 (122.8)		
Std. Deviation							
Elong, percent	Avg	14.0			19.4		
	Min	14.0			18.8		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg	211 (30.6)			214 (31.0)		
	Min	205 (29.7)			213 (30.9)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 87612

TABLE 6.2.2-ME10.5

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metla)

Specification:
Form: Bar-TIG welded, Inco weld 69 filler
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1255 K (1800 F), 1 hr, AC, weld, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	838.4 (121.6)			987.3 (143.2)		1003 (145.5)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	627 (91.0)			717.1 (104.0)		750.2 (108.8)
	Min						
Std. Deviation							
Elong, percent	Avg	13.3			13.6		12.7
	Min						
RA, percent	Avg	27.0			22.0		17.1
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1098 (159.2)			1393 (202.0)		1475 (214.0)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME10.6

Alloy Designation:	Inconel X-750 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Bar-TIG welded, Inco weld 69 filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Solution treated 1255 K (1800 F) 1 hr, AC; age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F), 8 hr, AC, weld and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	840.4 (121.9)			968.7 (140.5)		992.9 (144.0)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	649 (94.1)			800.5 (116.1)		861.8 (125.0)
	Min						
Std. Deviation							
Elong, percent	Avg	8.2			5.5		4.8
	Min						
RA, percent	Avg	27.0			17.0		14.5
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1172 (170.0)			1434 (208.0)		1485 (215.4)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

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TABLE 6.2.2-ME10.7

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Bar, TIG welded, Inco weld 69 filler
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1255 K (1800 F) 1 hr, AC; weld, Solution treated weldment 1255 K (1800 F) 1 hr, AC, age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F) 8hr, AC, test

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1096 (159.0)			1109 (160.8)		1124 (163.0)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	856.3 (124.3)			930.8 (135.0)		958.4 (139.0)
	Min						
Std. Deviation							
Elong, percent	Avg	9.0			5.6		5.5
	Min						
RA, percent	Avg	11.9			9.2		8.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1571 (227.8)			1710 (248.0)		1629 (236.2)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME10.8

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Bar, Vac. E B. Weld, no filler
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1255 K (1800 F) 1 hr, AC; weld, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	772.2 (112.0)			948.0 (137.5)		966.0 (140.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	552 (80.0)			677 (98.2)		730.8 (106.0)
	Min						
Std. Deviation							
Elong, percent	Avg	8.0			11.8		11.6
	Min						
RA, percent	Avg	30.8			25.0		19.6
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1009 (146.3)			1227 (178.0)		1337 (193.9)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME10.9

Alloy Designation:	Inconel X-750 Nickel-Base Alloy (Weld Metal)						
Specification:							
Form:	Bar, Vac. E. B. Weld, no filler						
Thickness, cm (in.):	Over 5.080 (2.000)						
Condition:	Solution treated 1255 K (1800 F) 1 hr, AC; weld, solution treated weldment 1255 K (1800 F) 1 hr, AC, age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F) 8 hr, AC, tested						

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1089 (157.9)			1082 (156.9)		1062 (154.1)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	841.9 (122.1)			903.2 (131.0)		913.6 (132.5)
	Min						
Std. Deviation							
Elong, percent	Avg	10.0			6.4		7.1
	Min						
RA, percent	Avg	10.3			8.7		8.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1496 (217.0)			163.3 (236.9)		1684 (244.2)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

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TABLE 6.2.2-ME10.10

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Bar, Vac. E.B. Weld, no filler
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1255 K (1800 F) 1 hr, AC; Age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F) 8 hr, AC, weld and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	806.7 (117.0)			920.5 (133.5)		936.3 (135.8)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	594 (86.2)			751.5 (109.0)		770.8 (111.8)
	Min						
Std. Deviation							
Elong, percent	Avg	3.2			2.6		3.0
	Min						
RA, percent	Avg	30.3			11.4		10.3
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1070 (155.2)			1320 (191.5)		1403 (203.5)
K_t = 10	Min						
No. of Spec. (No. of Heats.		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

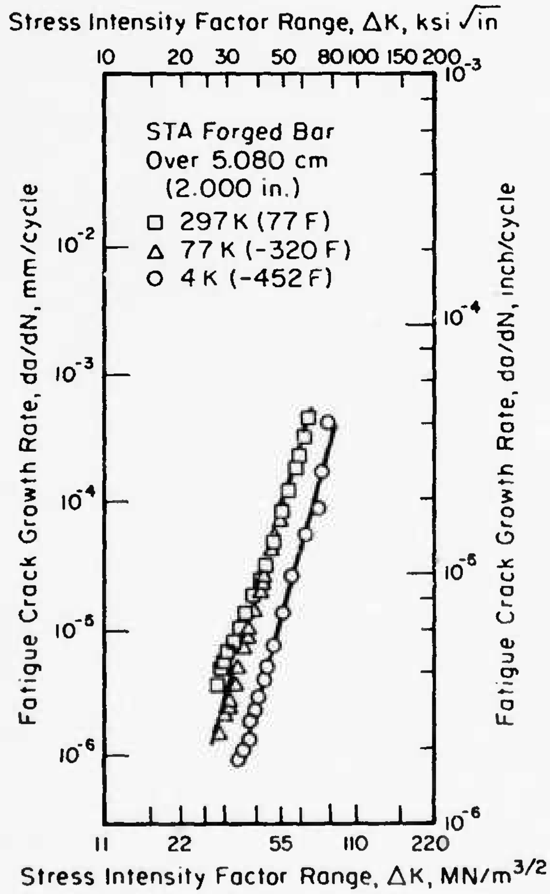

FIGURE 6.2.2-ME5. FATIGUE CRACK GROWTH RATES OF INCONEL X-750(94208G)

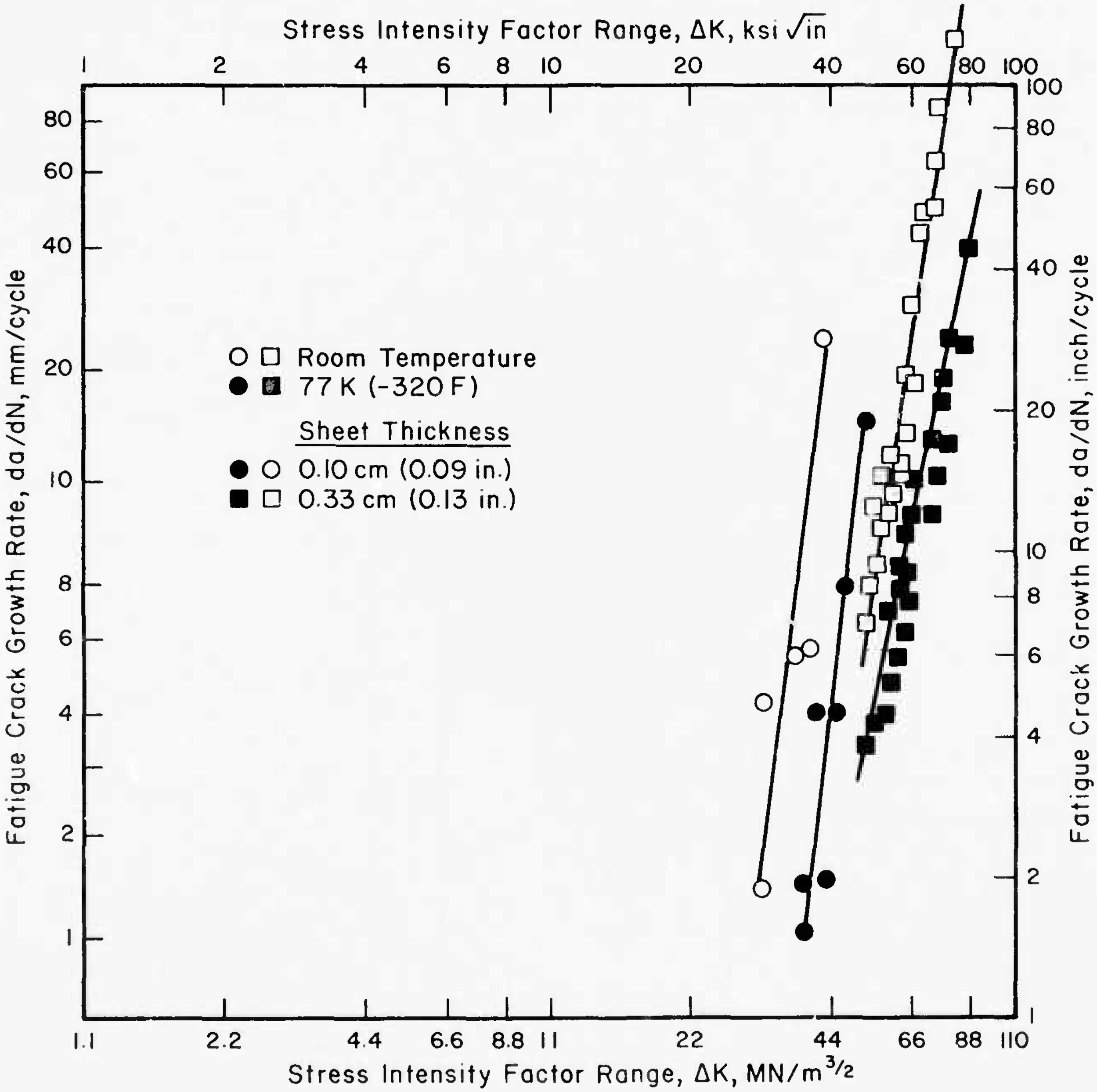

FIGURE 6.2.2-ME6. FATIGUE CRACK GROWTH RATE OF INCONEL X-750 NICKEL-BASE ALLOY SHEET [Annealed in vacuum, 1325 K (1925 F) 30 min + rapid furnace quenched with N_2 gas; heated in air at 978 K (1300 F) 20 hours, air cooled] [87612]

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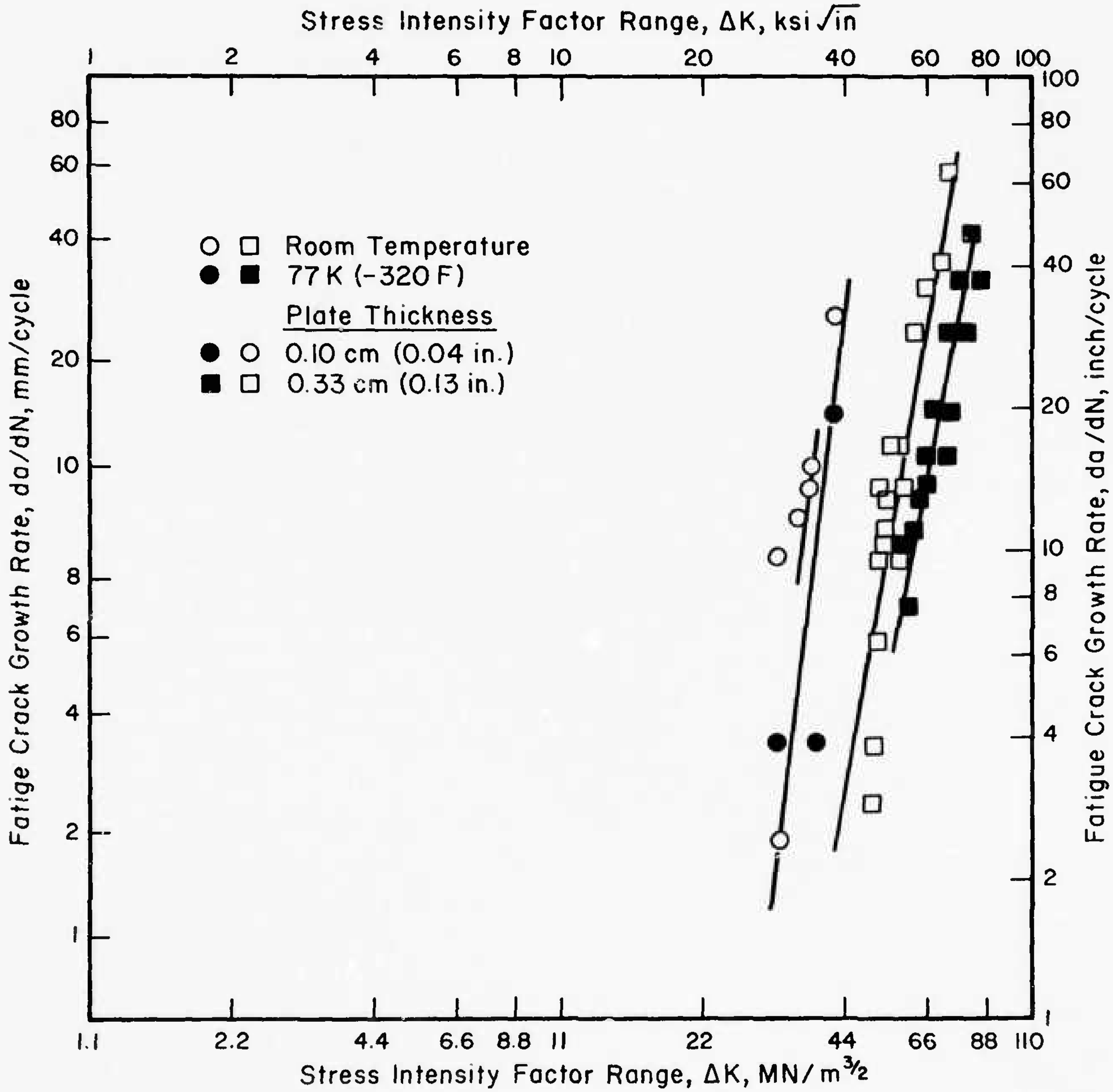


FIGURE 6.2.2-ME7. FATIGUE CRACK GROWTH RATE OF INCONEL X-750 NICKEL-BASE ALLOY SHEET TIG WELDED USING INCO WELD 69 FILLER [Weld specimens annealed in vacuum 1325 K (1925 F) 30 min + rapid furnace quenched with N_2 gas; heated in air at 978 K (1300 F) 20 hours, air cooled prior to testing] [87612]

TABLE 6.2.2-TR1

Alloy Designation: Inconel X 750 Nickel Alloy

Specification:
Form:
Dimension:
Condition: Solution Treated and Double Aged

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	11.4	9.27	7.51	3.62	1.61	
Btu hr^{-1} ft^{-1} F^{-1}	(6.59)	(5.36)	(4.34)	(2.09)	(0.93)	
Watts m^{-1} K^{-1}(a)	11.4	9.27	7.66	3.93	1.81	
Btu hr^{-1} ft^{-1} F^{-1}(a)	(6.59)	(5.36)	(4.43)	(2.27)	(1.05)	
No. of Spec.	2	2	2	2	2	
References: 94206, 94208						
Thermal Expansion (T_{273} to T)						
Longitudinal						
Percent	0	-0.186	-0.212	-0.220	-0.222	
No. of Spec.	1	1	1	1	1	
References: 95168						
Specific Heat						
Joules kg^{-1} K^{-1}	440	230	91*	7.10	2.73	1.09
Btu lb^{-1} F^{-1}	(0.105)	(5.50×10^{-2})	(2.17×10^{-2})	(1.70×10^{-3})	(6.52×10^{-4})	(2.61×10^{-4})
No. of Spec.	4	4	0	4	4	4
References: 95168						
Electrical Resistivity						
Ohm m	122.6×10^{-8}	118.8×10^{-8}	117.3×10^{-8}	117.1×10^{-8}	117.4×10^{-8}	
Ohm circular mil ft^{-1}	(737)	(715)	(706)	(704)	(706)	
Ohm m(a)	126.7×10^{-8}	124.4×10^{-8}	123.9×10^{-8}	123.8×10^{-8}	124.0×10^{-8}	
Ohm circular mil ft^{-1}(a)	(762)	(748)	(745)	(745)	(746)	
No. of Spec.	2	2	2	2	2	
References: 94206, 94208						

(a) Solution treated.
* Extrapolated.

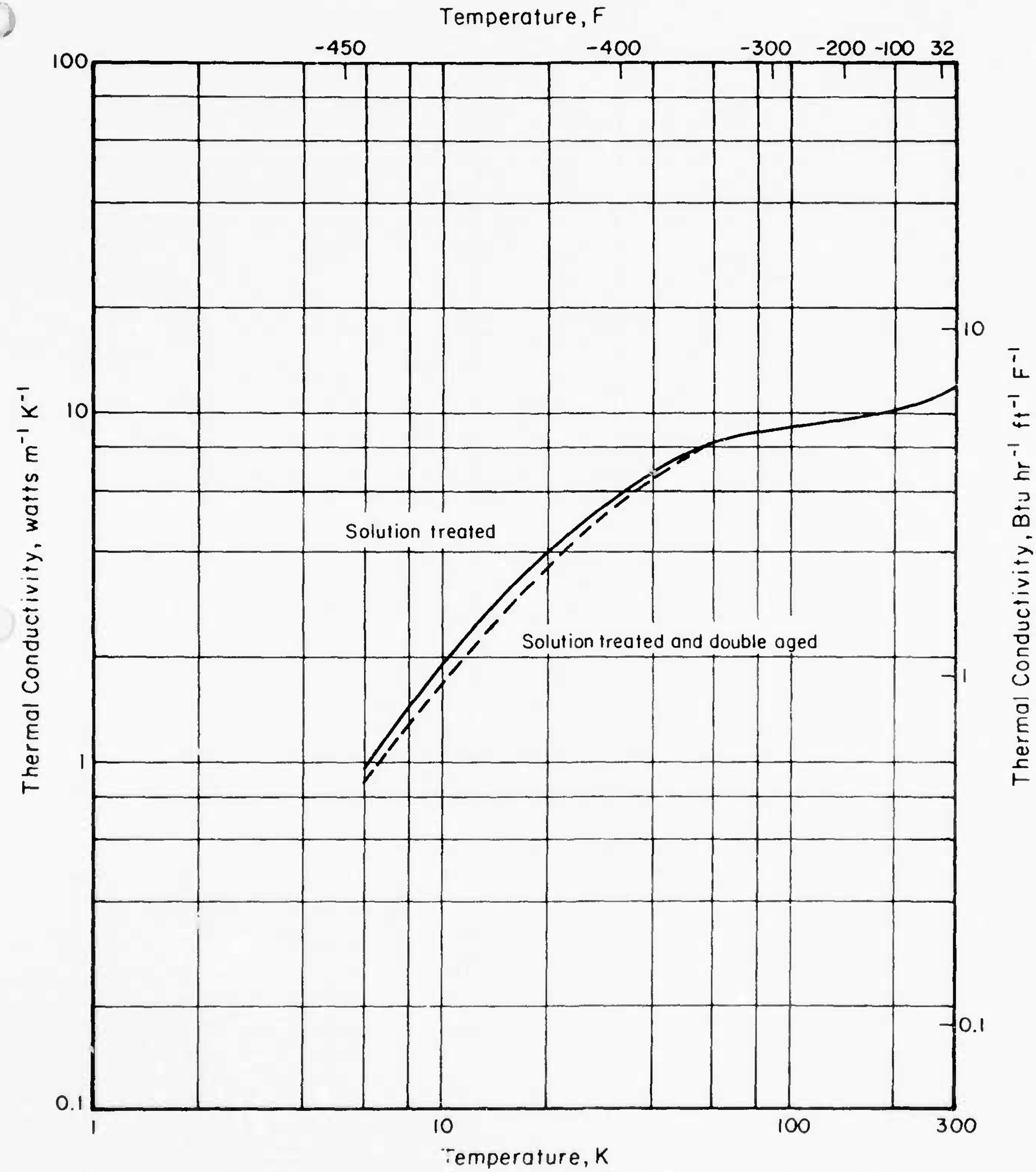


FIGURE 6.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

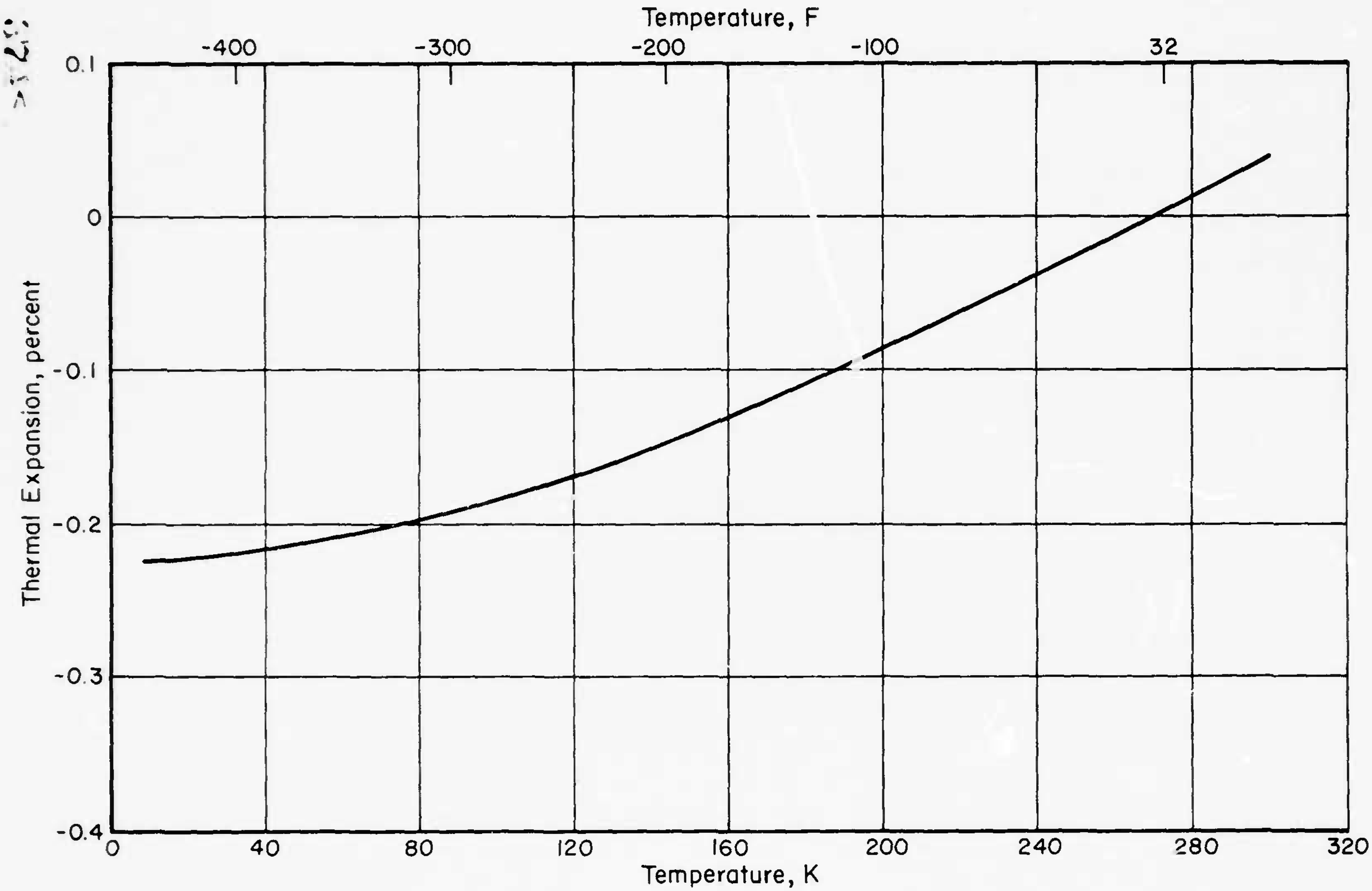


FIGURE 6.2.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

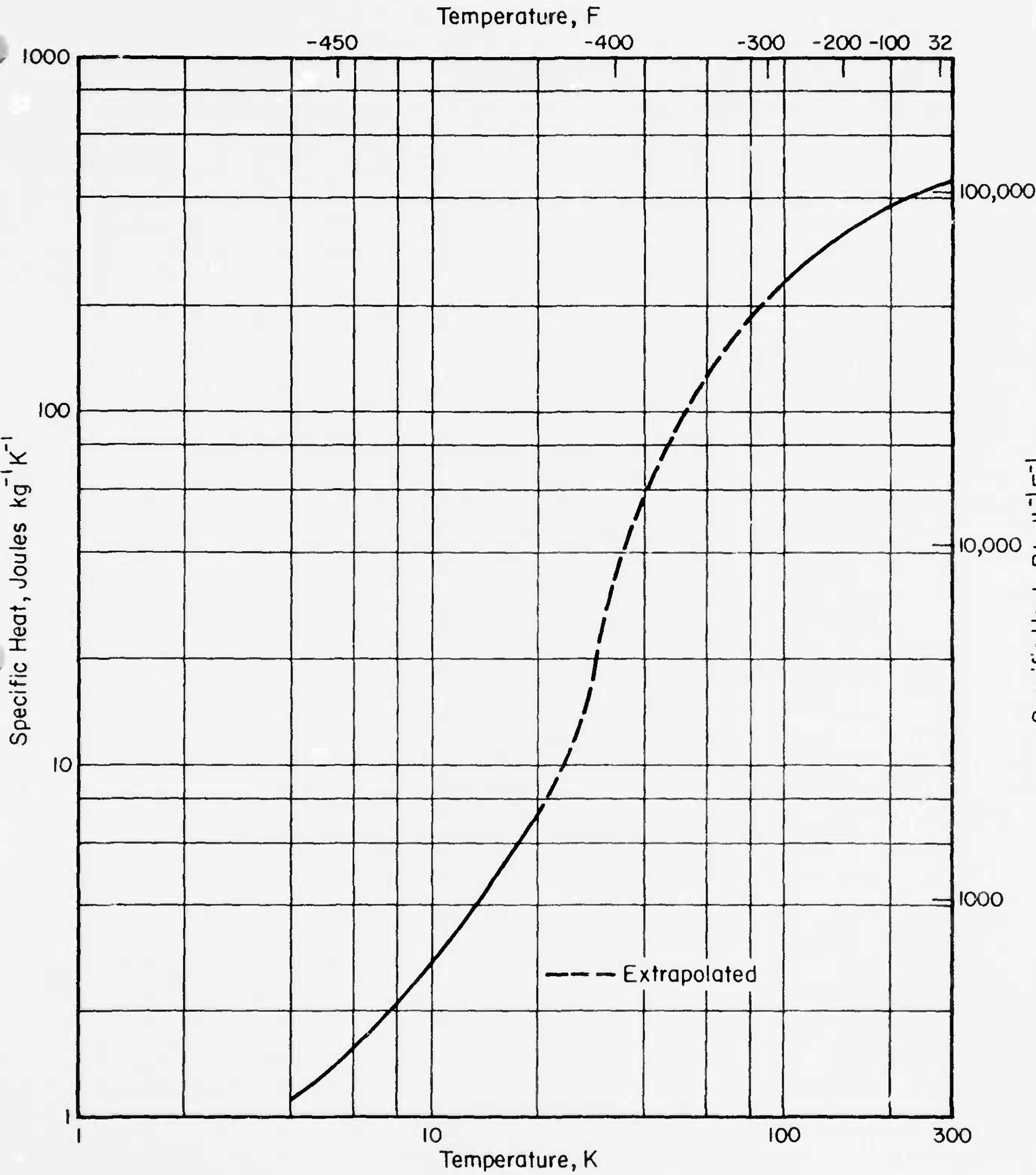


FIGURE 6.2.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

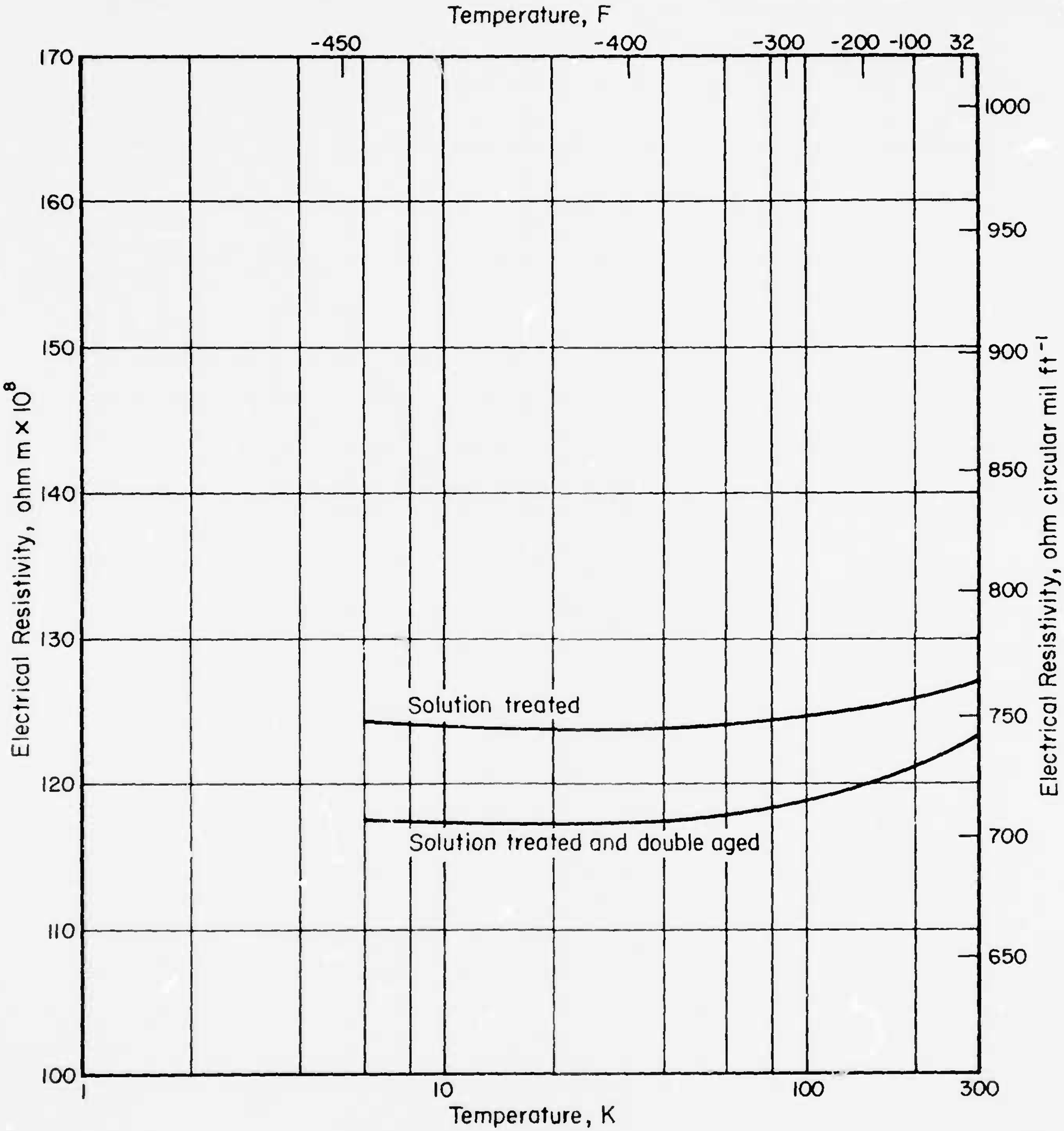
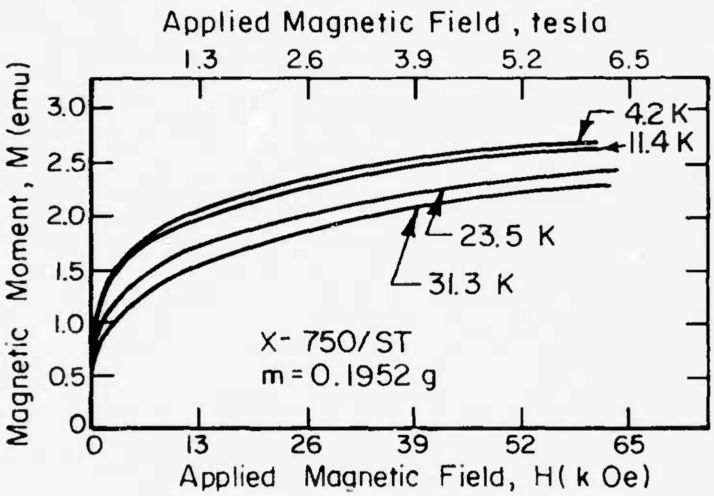


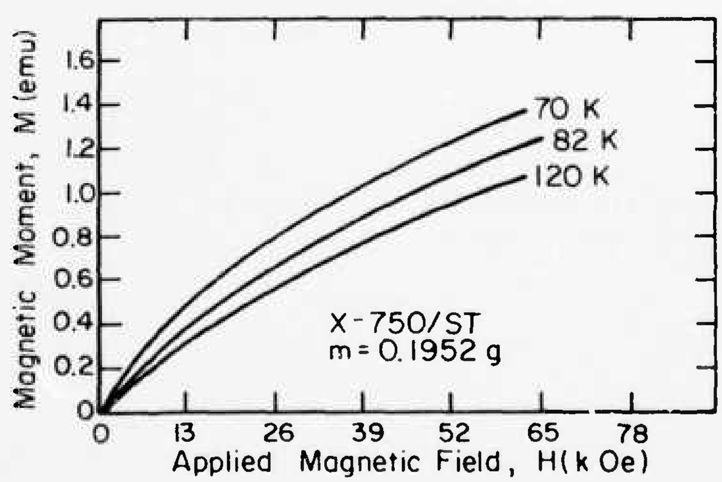
FIGURE 6.2.2-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

TABLE 6.2.2-MA1

Alloy Designation:	Inconel X-750	N07750
Specification:	IN X-750 ST	
Form:	Rod	
Dimension, cm(in.):	Not given	
Condition:	ST: Heated at 1800 F (1255 K) for 1 hr. and air cooled	
Curie temperature:	~130K (-225 F)	
Peak induction, B_S:	0.1433T (tesla)	



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD AT LOW LOW TEMPERATURES

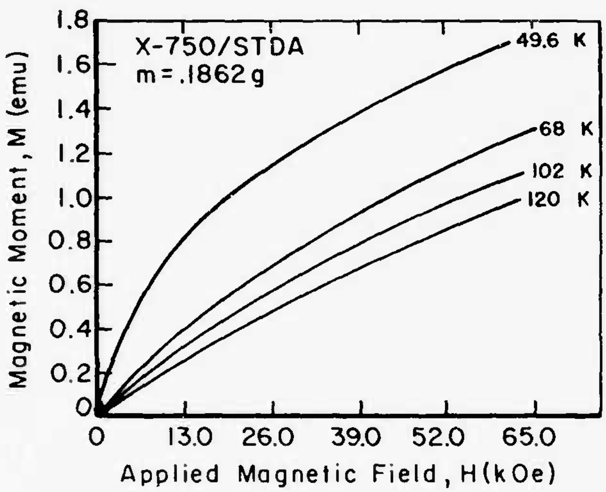


MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

Reference: 94206

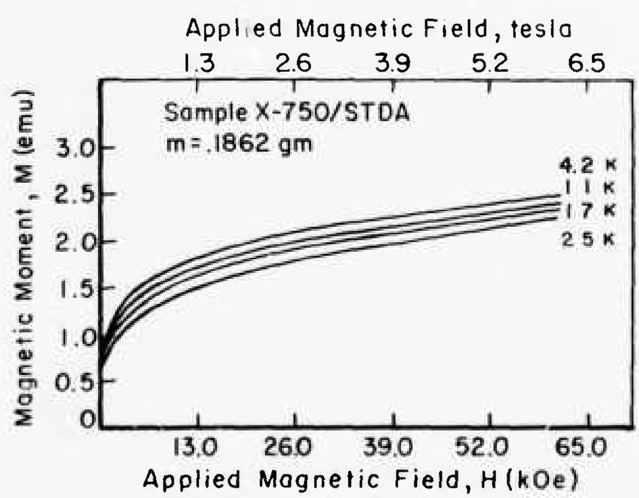
TABLE 6.2.2-MA2

Alloy Designation:	Inconel X-750	N07750
Specification:	IN X-750 STDA	
Form:	Rod	
Dimension, cm(in.):	Not given	
Condition:	STDA: solution treated, double aged, strained	
Curie temperature:	~130K (-225 F)	
Peak induction, B_S, at 4.2 K:	0.1477T (tesla)(strained)	



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

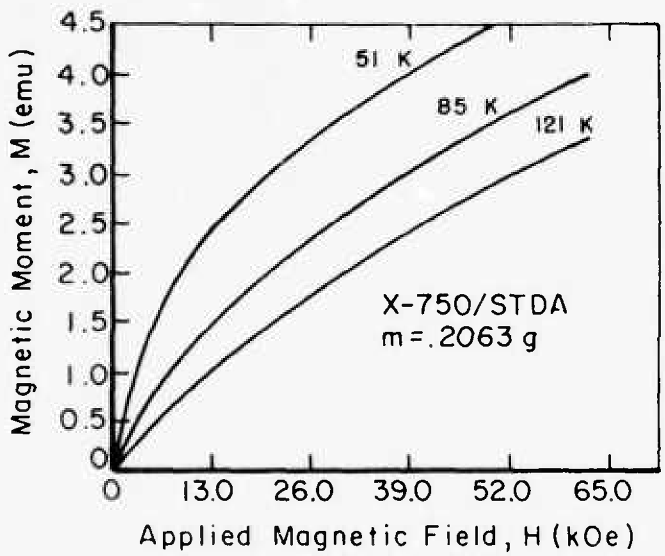
MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD



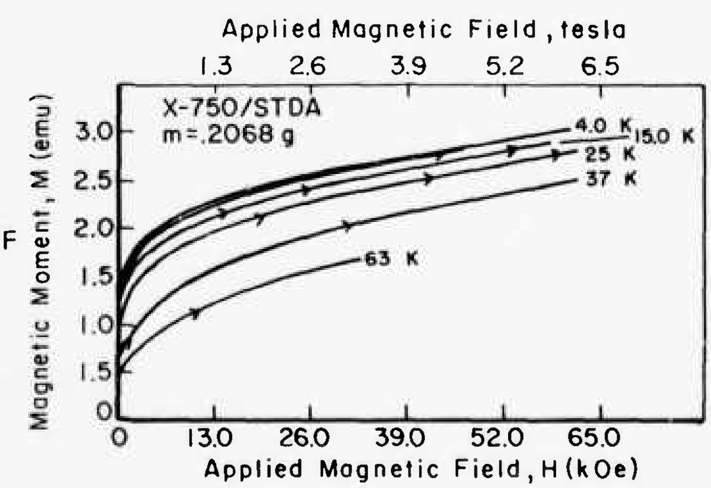
Reference: 94206

TABLE 6.2.2-MA3

Alloy Designation:	Inconel X-750	N07750
Specification:	IN X-750 STDA	
Form:	Rod	
Dimension, cm(in.):	Not given	
Condition:	STDA: solution treated, double aged, unstrained	
Curie temperature:	~130K (-255 F)	
Peak induction, B_s, at 412 K:	0.1552T (tesla)	



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD AT LOW TEMPERATURES

Reference: 94206

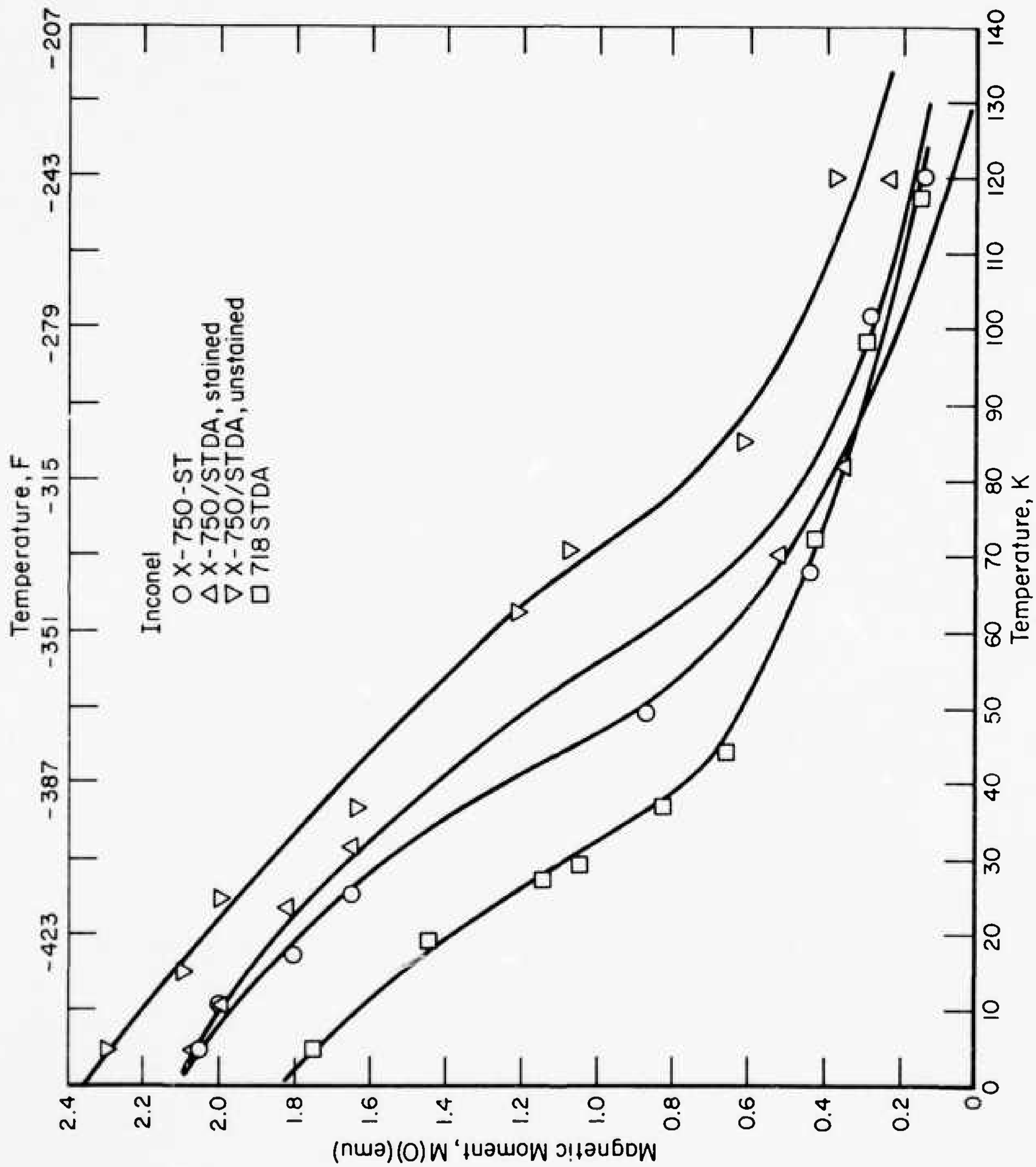


FIGURE 6.2.2-MA1. MAGNETIC MOMENT (EXTRAPOLATED) AS A FUNCTION OF TEMPERATURE

TABLE 6.2.3-ME1

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	AMS-5662B
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 cm (0.039 in.)
Condition:	Annealed, aged 992 K (1325 F) 8 hr, FC, 11 K (20 F) 1 hr to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1331 (193)	1476 (214)	1675 (243)	1910 (277)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1089 (158)	1179 (171)	1296 (188)	1420 (206)		
	Min						
Std. Deviation							
Elong, percent	Avg	20.9	23	28.8	25.6		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (3)	3 (1)	8 (3)	8 (3)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1407 (204)	1524 (221)	1593 (231)	1855 (269)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		8 (3)	3 (1)	8 (3)	8 (3)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1320 (192)	1469 (213)	1675 (243)	1855 (269)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1089 (158)	1172 (170)	1286 (186)	1376 (200)		
	Min						
Std. Deviation							
Elong, percent	Avg	20.3	23	24	24		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (3)		3 (1)	6 (2)	6 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1400 (203)	1538 (223)	1579 (229)	1820 (264)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		6 (2)	3 (1)	6 (2)	6 (2)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345, 65177

TABLE 6.2.3-ME1.1

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to C 099 (0.039)
Condition:	Annealed 1260 K (1810 F) 6 min

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	896 (130)			1241 (180)	1351 (196)	
	Min	889 (129)			1241 (180)	1324 (192)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	411 (59.6)			610 (88.4)	687 (99.7)	
	Min	407 (59.1)			607 (88.0)	685 (99.9)	
Std. Deviation							
Elong, percent	Avg	48.5			57.0	48.5	
	Min	47.5			56.5	48.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	752 (109)			993 (144)	1089 (158)	
K_t = 6.3	Min	738 (107)			972 (141)	1069 (155)	
No. of Spec. (No. of Heats)		2 (1)			2 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	883 (128)				1096 (159)	
	Min	876 (127)				1096 (159)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	397 (57.6)					
	Min	391 (56.7)					
Std. Deviation							
Elong, percent	Avg	48.8					
	Min	48.0					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	752 (109)					
K_t = 6.3	Min	752 (109)					
No. of Spec. (No. of Heats)		2 (1)					
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

TABLE 6.2.3-ME1.2

Alloy Designation:	**Inconel 718 Nickel-Base Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-TIG welded, no filler**
Thickness, cm (in.):	**Up to 0.099 (0.039)**
Condition:	**Annealed Sheet welded, aged[(a)], and tested as aged**

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1240 (179.8)			1551 (225.0)		
	Min	1193 (173.0)			1482 (205.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1080 (156.6)			1309 (189.8)		
	Min	1041 (151.0)			1262 (183.0)		
Std. Deviation							
Elong, percent	Avg	3.6			6.6		
	Min	3.0			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66577

(a) Aging treatment: 990 K (1325 F) 4 hr, FC to 895 K (1150 F) 4 hr, AC

TABLE 6.2.3-ME1.3

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed sheet, welded, aged[a], and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	1273 (184.6)			1640 (237.9)		
	Min	1220 (177.0)			1610 (233.5)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1109 (160.9)			1420 (206.0)		
	Min	1048 (152.0)			1379 (200.0)		
Std. Deviation							
Elong, percent	Avg	3.8			7.0		
	Min	3.0			6.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			2 (1)		
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66577
(a) Aging treatment: 1006 K (1350 F) 8 hr, FC to 922 K (1200 F) 10 hr, AC

TABLE 6.2.3-ME1.4

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	Annealed sheet, welded, aged[(a)], and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1291 (187.3)			1657 (240.3)		
	Min	1213 (176.0)			1617 (234.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1094 (158.6)			1332 (193.2)		
	Min	1007 (146.0)			1276 (185.0)		
Std. Deviation							
Elong, percent	Avg	4.8			5.5		
	Min	3.0			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)			3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66577

(a) Aging treatment: 1034 K (1400 F) 10 hr, FC to 922 K (1200 F) 10 hr, AC

TABLE 6.2.3-ME1.5

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed sheet, aged[a], welded, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	896.3 (130.0)			1156 (167.7)	1294 (187.7)	
	Min	892.8 (129.5)			1146 (166.2)	1275 (184.9)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	599 (86.9)			783.2 (113.6)	923.2 (133.9)	
	Min	595 (86.3)			779.8 (113.1)	894.9 (129.8)	
Std. Deviation							
Elong, percent	Avg	4.0			3.7	2.8	
	Min	4.0			3.5	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	687 (99.7)			890.1 (129.1)	977.7 (141.8)	
K_t = 6.3	Min	677 (98.3)			841.2 (122.0)	997.3 (137.4)	
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment: 990 K (1325 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC

TABLE 6.2.3-ME1.6

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	Annealed sheet, aged[(a)], welded, weldment aged[(a)], and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	1314 (190.6)			1558 (225.9)	1729 (250.7)	
	Min	1302 (188.8)			1534 (222.5)	1664 (241.4)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1151 (166.9)			1290 (187.1)	1413 (204.9)	
	Min	1140 (165.4)			1273 (184.7)	1395 (202.3)	
Std. Deviation							
Elong, percent	Avg	4.8			4.3	5.0	
	Min	4.5			3.0	4.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	1196 (173.5)			1321 (191.6)	1441 (209.0)	
K_t = 6.3	Min	1131 (164.0)			1252 (181.6)	1418 (205.7)	
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment before and after welding: 990 K (1325 F) 8 hr, FC to 895 k (1150 F) 10 hr, AC

TABLE 6.2.3-ME1.7

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: 20% cold worked

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1069 (155)			1407 (204)	1558 (226)	
	Min	1055 (153)			1393 (202)	1551 (225)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	917 (133)			1124 (163)	1227 (178)	
	Min	917 (133)			1096 (159)	1213 (176)	
Std. Deviation							
Elong, percent	Avg	21.5			32.0	36.2	
	Min	21.0			32.0	36.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1117 (162)			1420 (206)	1538 (223)	
K_t = 6.3	Min	1117 (162)			1420 (206)	1524 (221)	
No. of Spec. (No. of Heats)		2 (1)			2 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1055 (153)				1538 (223)	
	Min	1055 (153)				1531 (222)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	841 (122)					
	Min	834 (121)					
Std. Deviation							
Elong, percent	Avg	24.0					
	Min	24.0					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1103 (160)					
K_t = 6.3	Min	1082 (157)					
No. of Spec. (No. of Heats)		2 (1)					
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

TABLE 6.2.3-ME1.8

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	20% cold worked and aged 950 K (1250 F) 8 hr, FC to 894 K (1150 F) 10 hr, AC

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1400 (203)			1848 (268)	2075 (301)	
	Min	1393 (202)			1848 (268)	2062 (299)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1310 (190)			1544 (224)	1710 (248)	
	Min	1310 (190)			1538 (223)	1703 (247)	
Std. Deviation							
Elong, percent	Avg	12.5			20.2	21.8	
	Min	12.0			20.0	21.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg	206 (29.9)				224 (32.5)	
	Min	205 (29.7)				217 (31.4)	
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1552 (225)			1931 (280)	2034 (295)	
K_t = 6.3	Min	1538 (223)			1924 (279)	1979 (287)	
No. of Spec. (No. of Heats)		2 (1)			2 (1)	2 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1372 (199)					
	Min	1365 (198)					
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1241 (180)					
	Min	1227 (178)					
Std. Deviation							
Elong, percent	Avg	12.0					
	Min	12.0					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)					
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1524 (221)					
K_t = 6.3	Min	1510 (219)					
No. of Spec. (No. of Heats)		2 (1)					
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

TABLE 6.2.3-ME1.9

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	20% cold worked sheet, aged[a], welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	905.9 (13[illegible].4)			1183 (171.6)	1311 (190.1)	
	Min	901.8 (130.8)			1174 (170.3)	1302 (188.9)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	601 (87.1)			786.0 (114.0)	901.8 (130.8)	
	Min	594 (86.1)			775.7 (112.5)	893.6 (129.6)	
Std. Deviation							
Elong, percent	Avg	4.2			3.8	2.8	
	Min	4.0			3.5	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	732.2 (106.2)			901.1 (130.7)	1007 (146.0)	
K_t = 6.3	Min	692.2 (100.4)			868.1 (125.9)	976.3 (141.6)	
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment: 950 K (1250 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC

TABLE 6.2.3-ME1.10

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	20% cold worked sheet, aged[a], welded, weldment aged[a], and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1336 (193.8)			1644 (238.4)	1725 (250.2)	
	Min	1311 (190.1)			1631 (236.5)	1689 (244.9)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1196 (173.4)			1370 (198.7)	1447 (209.9)	
	Min	1183 (171.6)			1340 (194.4)	1397 (202.6)	
Std. Deviation							
Elong, percent	Avg	2.2			3.0	2.0	
	Min	2.0			3.0	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1254 (181.9)			1370 (198.7)	1440 (203.1)	
K_t = 6.3	Min	1180 (171.1)			1293 (187.6)	1396 (202.4)	
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment before and after welding: 950 K (1250 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC

TABLE 6.2.3-ME1.11

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	30% cold rolled and aged

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1586 (230)	1717 (249)		2013 (292)	2130 (309)	
	Min	1572 (228)	1703 (247)		1993 (289)	2089 (303)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1503 (218)	1586 (230)		1786 (259)	1855 (764)	
	Min	1496 (217)	1558 (226)		1779 (258)	1841 (267)	
Std. Deviation							
Elong, percent	Avg	7.1	10.9		15.7	14.6	
	Min	6.5	10.5		15.0	11.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg	209 (30.3)	210 (30.5)		221 (32.0)	223 (32.4)	
	Min	206 (29.9)	204 (29.6)		216 (31.3)	221 (32.0)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1710 (248)	1841 (267)		2013 (292)	2130 (309)	
K_t = 6.3	Min	1696 (246)	1827 (265)		1965 (285)	2089 (303)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
NTS, MN/m^2 (ksi)	Avg	1482 (215)	1455 (211)		1579 (229)	1737 (252)	
K_t = 19	Min	1448 (210)	1393 (202)		1531 (222)	1572 (228)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1538 (223)	1669 (242)		1882 (273)	2034 (295)	
	Min	1531 (222)	1662 (241)		1848 (268)	2027 (294)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1420 (206)	1503 (218)		1641 (238)	1731 (251)	
	Min	1407 (204)	1475 (214)		1613 (234)	1703 (247)	
Std. Deviation							
Elong, percent	Avg	7.0	8.4		13.3	16.0	
	Min	6.5	8.0		11.5	12.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg	209 (30.3)	210 (30.4)		219 (31.7)	225 (32.6)	
	Min	207 (30.0)	202 (29.3)		217 (31.4)	222 (32.2)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1710 (248)	1806 (262)		1965 (285)	2075 (301)	
K_t = 6.3	Min	1675 (243)	1800 (261)		1931 (280)	1944 (282)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
NTS, MN/m^2 (ksi)	Avg	1455 (211)	1358 (197)		1434 (208)	1662 (241)	
K_t = 19	Min	1407 (204)	1303 (189)		1338 (194)	1538 (223)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	

References: 60578

TABLE 6.2.3-ME1.12

Alloy Designation:	**Inconel 718 Nickel-Base Alloy (Weld Metal)**
Specification:	
Form:	**Sheet-TIG welded, no filler**
Thickness, cm (in.):	**Up to 0.099 (0.039)**
Condition:	**30% cold rolled and aged, sheet welded and tested as welded**

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	779 (113)	993 (144)		1172 (170)	1062 (154)	
	Min	738 (107)	951 (138)		1131 (164)	951 (138)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.1	3.0		1.9	0.6	
	Min	1.5	1.0		1.0	0.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	772 (112)	896 (130)		1000 (145)	1007 (146)	
	Min	729 (105)	827 (120)		979 (142)	958 (139)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.7	1.6		0.9	0.9	
	Min	2.5	1.0		0.5	0.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 60578

TABLE 6.2.3-ME1.13

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	30% cold rolled and aged sheet, welded, aged and tested as aged

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1324 (192)	1427 (207)		1600 (232)	1779 (258)	
	Min	1310 (190)	1379 (200)		1503 (218)	1751 (254)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6	1.5		1.8	1.2	
	Min	1.5	1.5		1.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1269 (184)	1386 (201)		1572 (228)	1717 (249)	
	Min	1255 (182)	1358 (197)		1524 (221)	1689 (245)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6	1.5		1.2	1.0	
	Min	1.5	1.5		1.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 60578

TABLE 6.2.3-ME2

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:	AMS-5596C
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed, aged 1034 K (1400 F) 10 hr, FC, 920 K (1200 F) 10 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	**1330 (193)**		**1634 (237)**	**1825 (265)**		
	Min	1269 (184)		1448 (210)	1772 (257)		
Std. Deviation		42.0 (6.10)		110 (16)			
TYS, MN/m^2 (ksi)	Avg	**1096 (159)**		**1282 (186)**	**1422 (206)**		
	Min	979 (142)		1148 (166)	1386 (201)		
Std. Deviation		74.5 (10.8)		98.6 (14.3)			
Elong, percent	Avg	**19.2**		**17.7**	**15.7**		
	Min	17		13	13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)		9 (2)	6 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66577, 83417

TABLE 6.2.3-ME5

Alloy Designation:	Inconel 718 Nickel-Base Alloy	N07718
Specification:	AMS-5596 C	
Form:	Sheet	
Thickness, cm (in.):	0.100 to 0.319 (0.040 - 0.125)	
Condition:	Annealed 1340 K (1950 F), AC, aged 1034 K (1400 F) 10 hr, FC, 920 K (1200 F) 10 hr, AC	

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 64 rms						
S_N at 10^5 cycles, MN/m^2 (ksi)	607 (88)		662 (96)	807 (117)		
Loading frequency 30-40 Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.46		0.40	0.45		
S_N at 10^6 cycles, MN/m^2 (ksi)	400 (58)		455 (66)	524 (76		
Loading frequency 30-40 Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.30		0.27	0.29		
S_N at 10^7 cycles, MN/m^2 (ksi)	324 (47)		427 (62)			
Loading frequency 30-40 Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.24		0.26			
Fatigue, Flexural Loading, Surface Finish 11 rms						
S_N at 10^5 cycles, MN/m^2 (ksi)	717 (104)		800 (116)	1020 (148)		
Loading frequency 30-40 Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.52		0.46	0.55		
S_N at 10^6 cycles, MN/m^2 (ksi)	496 (72)		579 (84)	703 (102)		
Loading frequency 30-40 Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.36		0.33	0.38		
S_N at 10^7 cycles, MN/m^2 (ksi)	434 (63)		476 (69)			
Loading frequency 30-40 Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.32		0.27			

References: 83417

TABLE 6.2.3-ME5.1

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	
Form:	Sheet
Thickness, cm (in.):	C.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed (solution treated)

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	880.5 (127.7)			1222 (177.2)	1300 (188.5)	
	Min	833.6 (120.9)			1151 (166.9)	1294 (187.7)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	549 (79.6)			745.3 (108.1)	722.6 (104.8)	
	Min	516 (74.8)			681 (98.8)	687 (99.6)	
Std. Deviation							
Elong, percent	Avg	41.8			51.3	56.0	
	Min	37.0			43.0	52.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg	203 (29.5)			211 (30.6)	211 (30.6)	
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	828.8 (120.2)			1105 (160.3)	1207 (175.1)	
K_t = 3.5	Min	828.1 (120.1)			1104 (160.1)	1200 (174.0)	
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	914.2 (132.6)			1242 (180.2)		
	Min	908.0 (131.7)			1223 (177.4)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	590 (85.5)			775.0 (112.4)		
	Min	584 (84.7)			770.8 (111.8)		
Std. Deviation							
Elong, percent	Avg	39.0			47.8		
	Min	38.0			44.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61996, 69021

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TABLE 6.2.3-ME5.2

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Sheet-TIG welded, 718-Alloy filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Solution treated sheet, TIG welded and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	839.8 (121.8)			1113 (161.4)	1228 (178.1)	
	Min	838.4 (121.6)			1077 (156.2)	1202 (174.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61996

TABLE 6.2.3-ME5.3

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed 1283 K (1850 F), aged 1075 K (1360 F)

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1388 (201.3)				1940 (281.3)	
	Min	1386 (201.0)				1935 (280.7)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1218 (176.6)				1460 (211.7)	
	Min	1213 (176.0)				1454 (210.9)	
Std. Deviation							
Elong, percent	Avg	19.3				18.4	
	Min	18.5				16.6	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)				3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 78611

TABLE 6.2.3-ME5.4

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 718-Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Sheet annealed at 1283 K (1850 F), aged at 1075 K (1360 F), welded, and tested as welded

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1411 (204.7)				1794 (260.2)	
	Min	1407 (204.0)				1784 (258.7)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1241 (180.0)				1517 (220.0)	
	Min	1234 (179.0)				1483 (215.1)	
Std. Deviation							
Elong, percent	Avg	9.3				4.6	
	Min	8.0				4.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)				3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 78611

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TABLE 6.2.3-ME5.5

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, 718 Alloy filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Sheet annealed 1225 K (1752 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	779.1 (113.0)			1050 (152)	869 (126)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	552 (80.0)			807 (117)	493 (71.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	4.0			3.2	4.1	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg	201 (29.2)			211 (30.6)	194 (28.2)	
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.25			0.23	0.34	
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 89800

TABLE 6.2.3-ME6

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5597A
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed 1340 (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	**1251 (182)**		**1502 (218)**			
	Min	1239 (180)		1467 (213)			
Std. Deviation		9.31 (1.35)		18.5 (2.68)			
TYS, MN/m^2 (ksi)	Avg	**1014 (147)**		**1196 (174)**			
	Min	995 (144)		1172 (170)			
Std. Deviation		13.1 (1.90)		23.0 (3.34)			
Elong, percent	Avg	**16.7**		**14.6**			
	Min	15		13			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (1)		10 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 63649

TABLE 6.2.3-ME6.1

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:
Form: Plate-TIG welded, 718 Alloy filler
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Plate TIG welded, weldment annealed 1340 K (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F) 10 hr, AC, and tested as aged

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1273 (184.7)				1556 (225.7)	
	Min	1262 (183.0)				1527 (221.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1072 (155.5)				1237 (179.4)	
	Min	1055 (153.0)				1207 (175.1)	
Std. Deviation							
Elong, percent	Avg	16				13.8	
	Min	15				11.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (1)[a]				3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 63649

(a) Room-temperature values contain a degree of uncertainty because the precise location of fracture (in or out of weld metal) was not given.

TABLE 6.2.3-ME6.2

Alloy Designation:	**Inconel 718 Nickel-Base Alloy (Weld Metal)**
Specification:	
Form:	**Plate-TIG welded, 718 Alloy filler**
Thickness, cm (in.):	**1.270 to 2.540 (0.500 to 1.000)**
Condition:	**Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged**

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1320 (192)			1540 (223)		
	Min	1050 (152)			1410 (205)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1110 (161)			1210 (176)		
	Min	1030 (149)			1170 (169)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)			4 (2)		
E, GN/m^2 (10^6 psi)	Avg	220 (31.9)			236 (34.2)		
	Min	197 (28.5)			214 (31.1)		
No. of Spec. (No. of Heats)		7 (3)			3 (2)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90717

TABLE 6.2.3-ME6.3

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Plate-EB welded, no filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1420 (206)			1540 (224)		
	Min	1360 (197)			1450 (211)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1110 (161)			1330 (193)		
	Min	1090 (158)					
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)					
E, GN/m^2 (10^6 psi)	Avg	212 (30.7)			214 (31.0)		
	Min	203 (29.4)					
No. of Spec. (No. of Heats)		5 (2)			1		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

405 References: 90717

TABLE 6.2.3-ME6.4

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Plate-Plasma-Arc Welded, 718 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1340 (195)			1550 (225)		
	Min	1340 (194)			1500 (218)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1100 (159)			1390 (202)		
	Min	1090 (158)			1380 (200)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg	230 (33.4)			221 (32.0)		
	Min	221 (32.1)			201 (29.2)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90717

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TABLE 6.2.3-ME6.5

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Plate-TIG welded, 718 Alloy filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate annealed 1340 K (1950 F) 1 hr, AC; aged 8-10 hr 970 K (1350 F), FC to 922 K (1200 F) total aging time of 20 hr, AC; welded, tested as welded

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	969.4 (140.6)				1299 (188.4)	
K_t = 6.3	Min	930.8 (135.0)				1245 (180.5)	
No. of Spec. (No. of Heats)		4 (1)				6 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 69021

TABLE 6.2.3-ME11

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	AMS-5662 B
Form:	Forgings (thick section)
Thickness, cm (in.):	2.5 to 10 cm (1.0 to 4.0 in.)
Condition:	Annealed 1255 K (1800 F) 45 min, AC, aged 992 K (1325 F) 8 hr, AC to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1338 (194)	1350 (196)	1634 (237)	1679 (244)	1813 (263)	
	Min	1282 (186)	1340 (194)	1617 (234)	1573 (228)	1800 (261)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1151 (167)	1189 (172)	1296 (188)	1320 (192)	1407 (204)	
	Min	1124 (163)	1178 (171)	1243 (180)	1270 (184)	1372 (199)	
Std. Deviation							
Elong, percent	Avg	23.7	29	26.0	28.2	20.6	
	Min	14.3	28	20.2	26	19.5	
RA, percent	Avg	35.4	44.6	34.3	41.5	20.2	
	Min	16.8	43.5	18.9	38.5	16.3	
No. of Spec. (No. of Heats)		7 (2)	4 (1)	6 (2)	4 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	2034 (295)	2168 (314)	2352 (341)	2392 (347)		
K_t = 6.3	Min	1988 (288)	2148 (312)	2277 (330)	2352 (341)		
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1288 (187)	1363 (198)	1631 (236)	1743 (253)		
	Min	1248 (181)	1344 (195)	1600 (232)	1736 (252)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1154 (167)	1188 (172)	1287 (187)	1354 (196)		
	Min	1138 (165)	1179 (171)	1272 (184)	1333 (193)		
Std. Deviation							
Elong, percent	Avg	18.5	22.2	27.5	24.5		
	Min	18	20	25	15		
RA, percent	Avg	28	34.8	39.1	29.8		
	Min	27.5	31	36.5	23.5		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1934 (280)	2062 (299)	2237 (324)	2296 (333)		
K_t = 6.3	Min	1864 (270)	2056 (298)	2216 (321)	2262 (328)		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 82966, 95168

TABLE 6.2.3-ME12

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5662B
Form: Forgings (thick section)
Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)
Condition: Annealed 1255 K (1800 F) 45 min, AC, aged 992 K (1325 F) 8 hr, AC to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 1º hr, AC

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Short Transverse											
TUS, MN/m^2 (ksi)	Avg	1289	(187)	1371	(199)	1579	(229)	1635	(237)		
	Min	1274	(185)	1354	(196)	1537	(223)	1573	(228)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	1144	(166)	1202	(174)	1288	(187)	1344	(195)		
	Min	1124	(163)	1189	(172)	1271	(184)	1326	(192)		
Std. Deviation											
Elong, percent	Avg	17		17.2		14		13.8			
	Min	14		13		12		11			
RA, percent	Avg	23		20		14		11.8			
	Min	17.5		12		12		8			
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1865	(270)	1889	(274)	2057	(298)	1968	(286)		
K_t = 6.3	Min	1803	(262)	1800	(261)	1995	(289)	1909	(277)		
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 82966

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TABLE 6.2.3-ME13

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	AMS-5662 B
Form:	Forgings (thick section)
Thickness, cm (in.):	2.5 to 10 cm (1.0 to 4.0 in.)
Condition:	Annealed 1255 K (1800 F) 45 min, AC, aged 922 K (1325 F) 8 hr, AC to 895 K (1150 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Compression, Longitudinal											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Compression, Transverse											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Shear[(a)]											
SUS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Impact, Charpy V											
Long., J(ft-lb)	Avg	85.4	(63)	66.4	(49)	66.4	(49)	58.3	(43)		
	Min	82.7	(61)	65.1	(48)	54.2	(40)	56.9	(42)		
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
Short Transverse, J(ft-lb)	Avg	36.6	(27)	23.7	(17.5)	28.5	(21)	40.7	(30)		
	Min	35.2	(26)	21.7	(16)	19.0	(14)	35.2	(26)		
No. of Spec. (No. of Heats)		5	(1)	4	(1)	5	(1)	4	(1)		
Fracture Toughness[(b)]											
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg	96.3	(87.8)	106	(95.6)	103.2	(94)			112.3	(102.3)
	Min	91.5	(83.4)	100	(91.2)	96.5	(88.0)			104	(94.8)
Orientation: T – S											
No. of Spec. (No. of Heats)		3	(1)	2	(1)	3	(1)			3	(1)
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg										
(From PTSC spec.)(–)	Min										
No. of Spec. (No. of Heats)											

References: 82966, 95168

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data: CT

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TABLE 6.2.3-ME14

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5664 A
Form: Forgings (thick section)
Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)
Condition: Annealed 1340 K (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	1302	(190)	1371	(199)	1640	(238)	1695	(246)		
	Min	1248	(181)	1366	(198)	1627	(236)	1627	(236)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	1041	(151)	1132	(164)	1212	(176)	1338	(194)		
	Min	993	(144)	1130	(164)	1200	(174)	1249	(181)		
Std. Deviation											
Elong, percent	Avg	27.4		27.2		31.8		25.6			
	Min	24.5		26		27		23			
RA, percent	Avg	41.7		44.1		36.4		35.8			
	Min	36		41.5		30.5		32.7			
No. of Spec. (No. of Heats)		7	(2)	4	(1)	4	(1)	7	(2)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1898	(275)	2063	(299)	2276	(330)	2295	(333)		
K_t = 6.3	Min	1800	(261)	2036	(295)	2246	(326)	2223	(322)		
No. of Spec. (No. of Heats)		6	(2)	4	(1)	4	(1)	7	(2)		
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	1267	(184)	1360	(197)	1622	(235)	1672	(242)		
	Min	1260	(183)	1355	(196)	1613	(234)	1523	(221)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	1009	(146)	1139	(165)	1229	(178)	1277	(185)		
	Min	1002	(145)	1125	(163)	1222	(177)	1270	(184)		
Std. Deviation											
Elong, percent	Avg	23.4		19.2		26.2		22.2			
	Min	18.5		16		23		18			
RA, percent	Avg	30.5		22.2		26.1		25.0			
	Min	22		21		24.5		20.5			
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1823	(265)	1961	(284)	2167	(314)	2206	(320)		
K_t = 6.3	Min	1757	(255)	1933	(280)	2089	(303)	2153	(312)		
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 69021, 62966

TABLE 6.2.3-ME16.1

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:
Form: Forgings (thick section)
Thickness, cm (in.): Over 10 cm (4.0 in)
Condition: Solution treated 1225 K (1800 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1347 (195.4)			1640 (237.8)		1670 (242.2)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1164 (168.8)			1344 (194.9)		1406 (203.9)
	Min						
Std. Deviation							
Elong, percent	Avg	12.0			10.1		9.4
	Min						
RA, percent	Avg	14.8			9.1		10.0
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1749 (253.6)			1876 (272.1)		1927 (279.5)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.3-ME16.2

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	
Form:	Forgings (thick section)
Thickness, cm (in.):	Over 10 (4.0)
Condition:	Soltuion treated 1255 K (1800 F) 1 hr, AC; aged 922 k (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)					4 (-452)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
J_{Ic} MN/m (in.-lb/$in.^2$)	Avg	0.021 (120)					0.027 (152)
	Min						
Orientation: --							
No. of Spec. (No. of Heats)		1					1
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(--)	Min						
No. of Spec. (No. of Heats)							

References: 95168

(a) **Indicate specimen design and orientation for shear specimens:**
(b) **Indicate specimen design for K_{Ic} data:**

TABLE 6.2.3-ME16.3

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Forgings (thick section), TIG welded, Alloy 718 filler
Thickness, cm (in.):	Over 10 (4.0)
Condition:	Soltuion treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1259 (182.6)			1436 (208.2)		1651 (239.4)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1094 (158.6)			1281 (185.8)		1273 (184.6)
	Min						
Std. Deviation							
Elong, percent	Avg	1.7			1.8		28.2
	Min						
RA, percent	Avg	5.7			4.3		33.5
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1391 (201.8)			1470 (213.2)		2282 (330.9)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1					
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

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TABLE 6.2.3-ME16.4

Alloy Designation:	Inconel 718 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Forgings (thick section) -TIG welded, Alloy 718 filler
Thickness, cm (in.):	Over 10 (4.0)
Condition:	Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F), 1 hr, AC; aged 922 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg				51.5 (46.5)		52.1 (47.1)
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 95188

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

415<

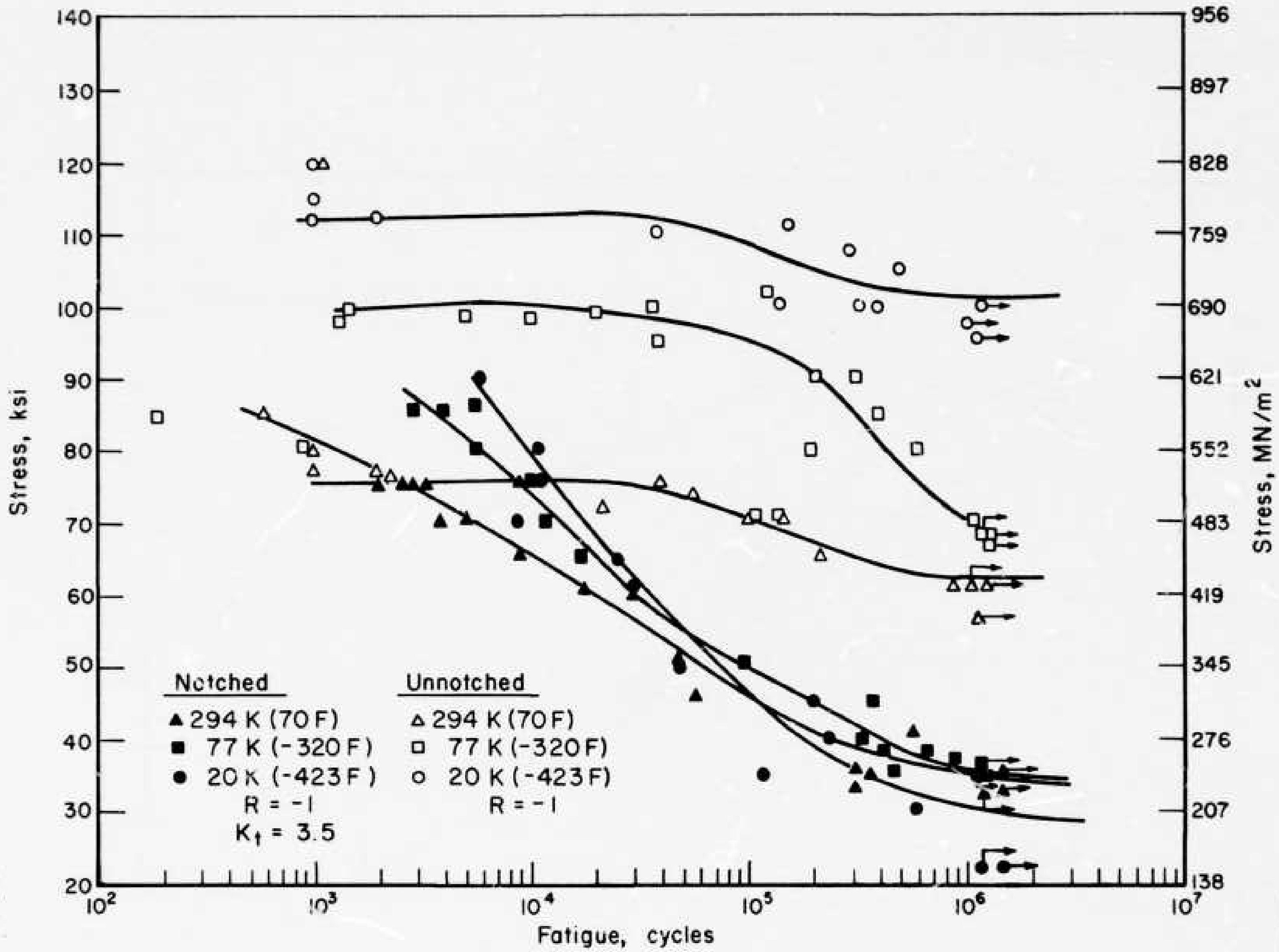


FIGURE 6.2.3-ME3. AXIAL FATIGUE LIFE CURVES FOR LOADING ON SPECIMENS OF SOLUTION TREATED INCONEL 718 NICKEL ALLOY SHEET 0.25 cm (0.100 in.) THICK [61996]

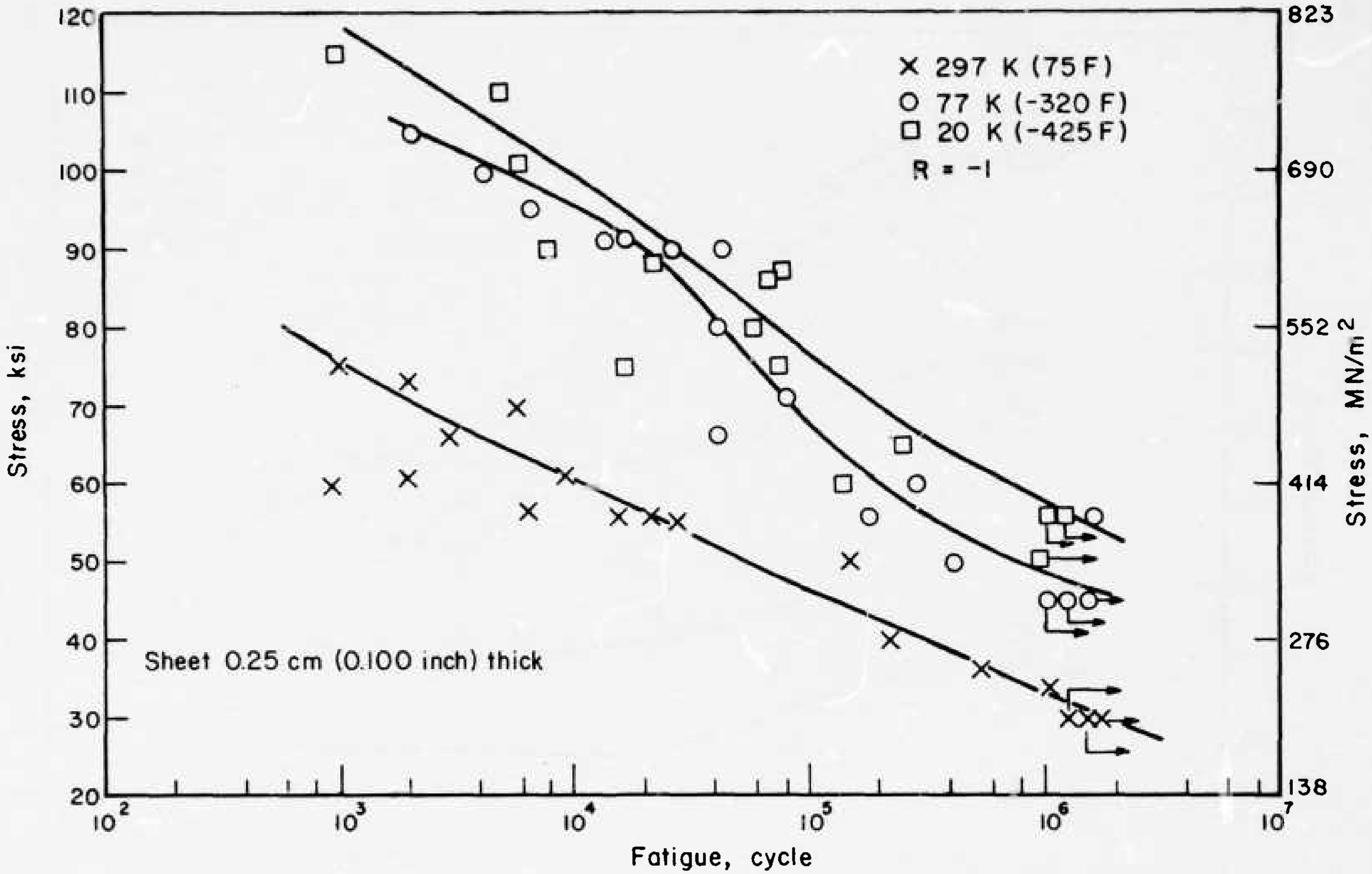


FIGURE 6.2.3-ME4. AXIAL FATIGUE LIFE CURVES FOR LOADING ON SPECIMENS OF INCONEL 718 SHEET ANNEALED, TIG WELDED (718 ALLOY FILLER), AND TESTED AS WELDED [61996]

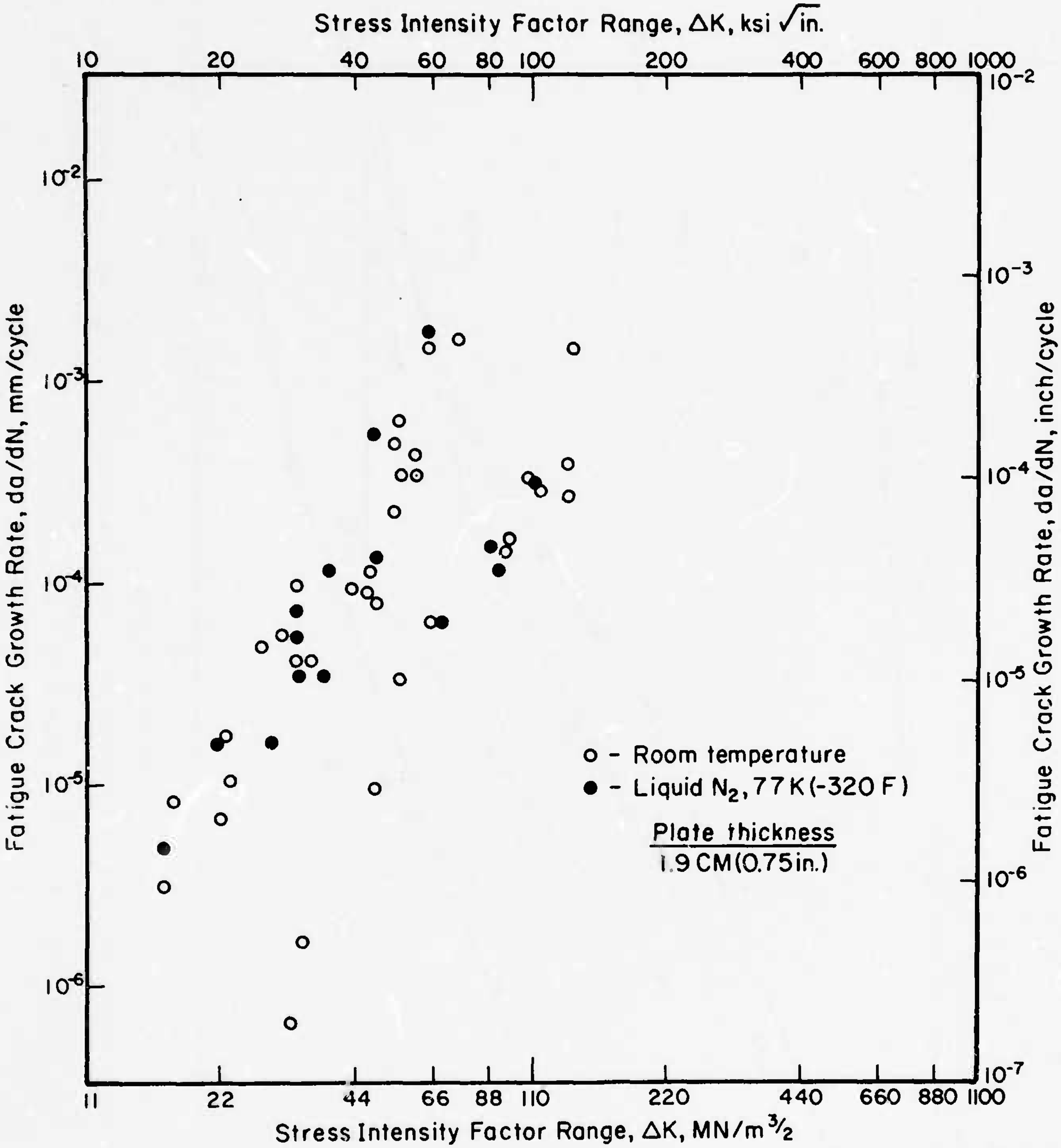


FIGURE 6.2.3-ME5. FATIGUE CRACK GROWTH RATE OF WELDED AND UNWELDED INCONEL 718 NICKEL-BASE ALLOY PLATE [Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F), AC; tested as aged, unwelded plate aged by same treatment] [90717]

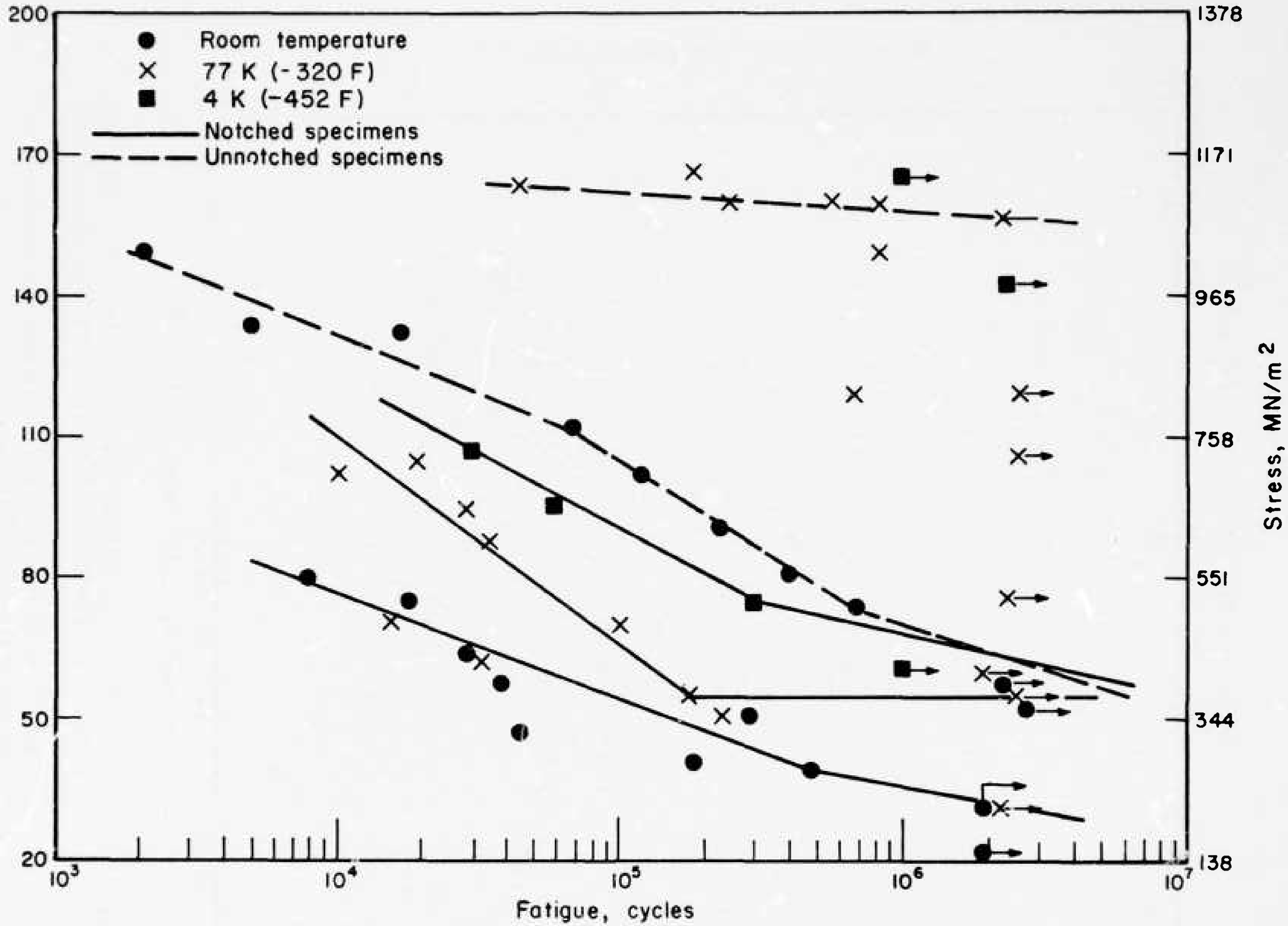


FIGURE 6.2.3-ME6. AXIAL FATIGUE LIFE CURVES FOR LOADING ON SPECIMENS OF NOTCHED AND UNNOTCHED INCONEL 718 BAR, 1.270 cm (0.500 in.) DIAMETER [Heat treatment: solution treated, then aged 922 K (1324 F) 8 hr, FC 2 hr 895 K (1150 F) 8 hr, AC] [95168]

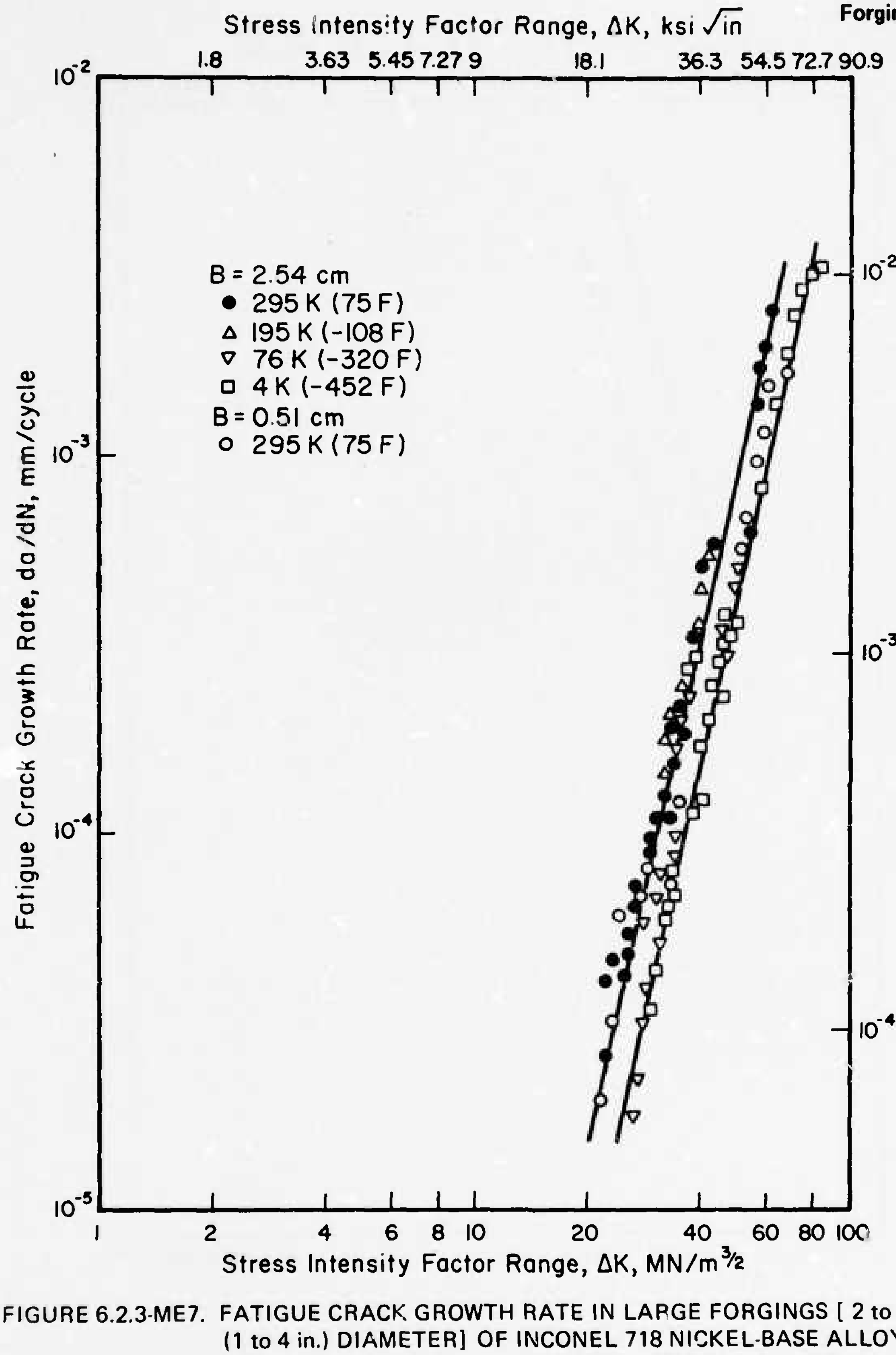


FIGURE 6.2.3-ME7. FATIGUE CRACK GROWTH RATE IN LARGE FORGINGS [2 to 10 cm (1 to 4 in.) DIAMETER] OF INCONEL 718 NICKEL-BASE ALLOY [*Heat treatment: solution treated 1255 K (1800 F) 3/4 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC*]

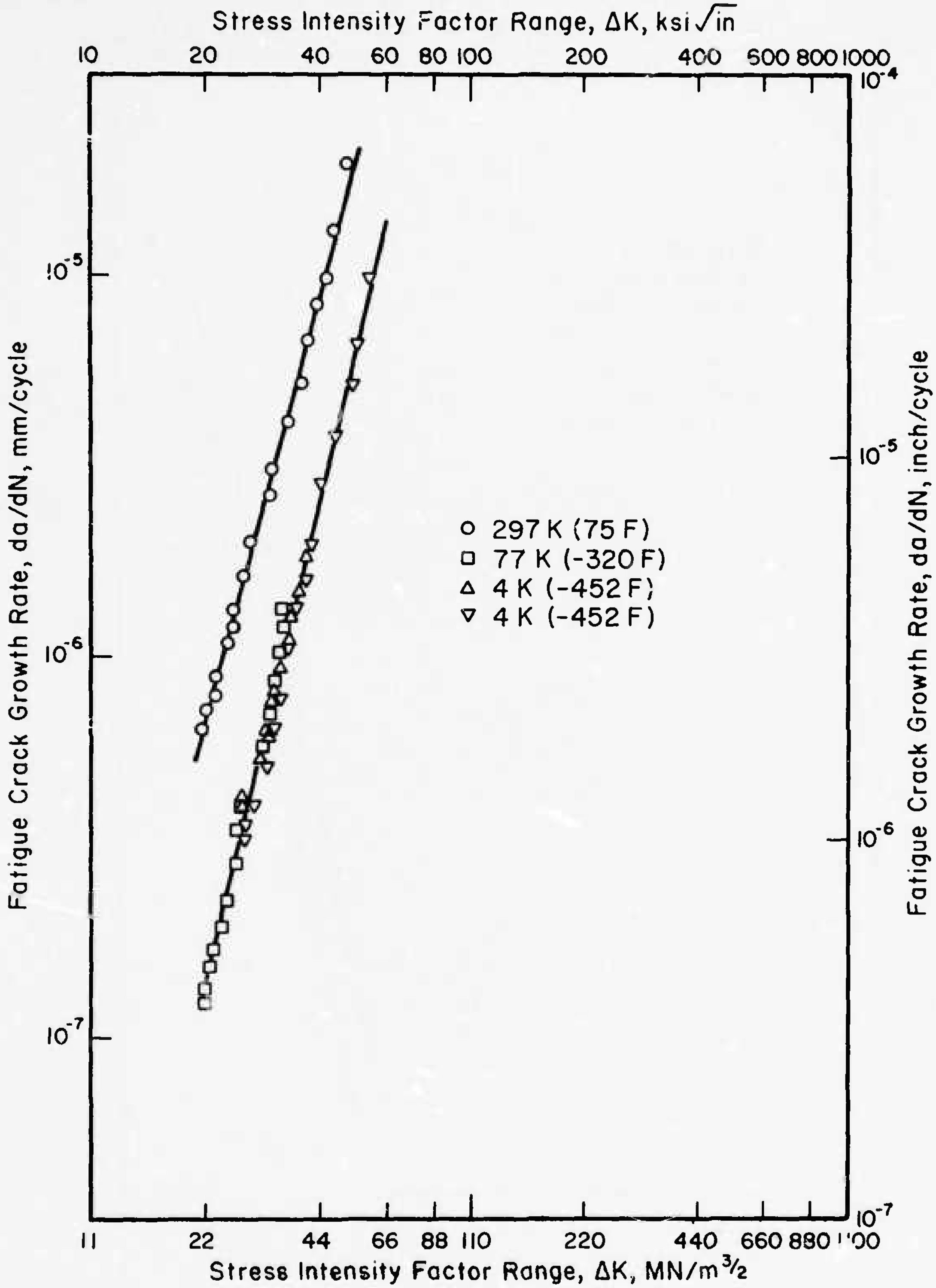


FIGURE 6.2.3-ME8. FATIGUE CRACK GROWTH RATE IN LARGE FORGINGS [OVER 10 cm (4 in.) DIAMETER] OF INCONEL 718 NICKEL-BASE ALLOY [Heat treatment: solution treated 1255 K (1800 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC]

TABLE 6.2.3-TR1

Alloy Designation: Inconel 718 Nickel Alloy N07718

Specification:
Form:
Dimension:
Condition: Annealed except as noted below

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	9.3		7.0		5.3		2.95		1.48			
Btu hr^{-1} ft^{-1} F^{-1}		(5.38)		(4.05)		(3.06)		(1.71)		(0.856)		
No. of Spec.	2		2		2		2		2			
References: 82097, 77044												
Watts m^{-1} K^{-1} (1)	10.9		7.09		5.05		2.40		1.08			
Btu hr^{-1} ft^{-1} F^{-1}		(6.30)		(4.10)		(2.92)		(1.39)		(0.624)		
No. of Spec.	1		1		1		1		1			
References: 96885												
Thermal Expansion (T_{273} to T) Longitudinal (1)												
Percent	0		-0.183		-0.208		-0.213		-0.213		-0.213	
No. of Spec.	3		3		2		2		2		2	
References: 74405, 70525, 94208												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m	125×10^{-8}		120×10^{-8}		119×10^{-8}		118×10^{-8}		118×10^{-8}		118×10^{-8}	
Ohm circular mil ft^{-1}		(752)		(722)		(716)		(710)		(710)		(710)
No. of Spec.	5		5		5		5		5		4	
References: 79561, 82097, 90164, 77044, 94206												
Ohm m (1)	1.14×10^{-8}		1.09×10^{-8}		1.08×10^{-8}		1.08×10^{-8}		1.08×10^{-8}			
Ohm circular mil ft^{-1}		(686)		(656)		(650)		(650)		(650)		
No. of Spec.	1		1		1		1		1			
References: 96885												
Magnetothermal Conductivity												
Watts m^{-1} K^{-1} — H Tesla												
Watts m^{-1} K^{-1} — 0									1.15			
Btu hr^{-1} ft^{-1} F^{-1}										(0.664)		
Watts m^{-1} K^{-1} — 8									1.10			
Btu hr^{-1} ft^{-1} F^{-1}										(0.636)		
No. of Spec.									1			
References: 94208												

(1) Age Hardened

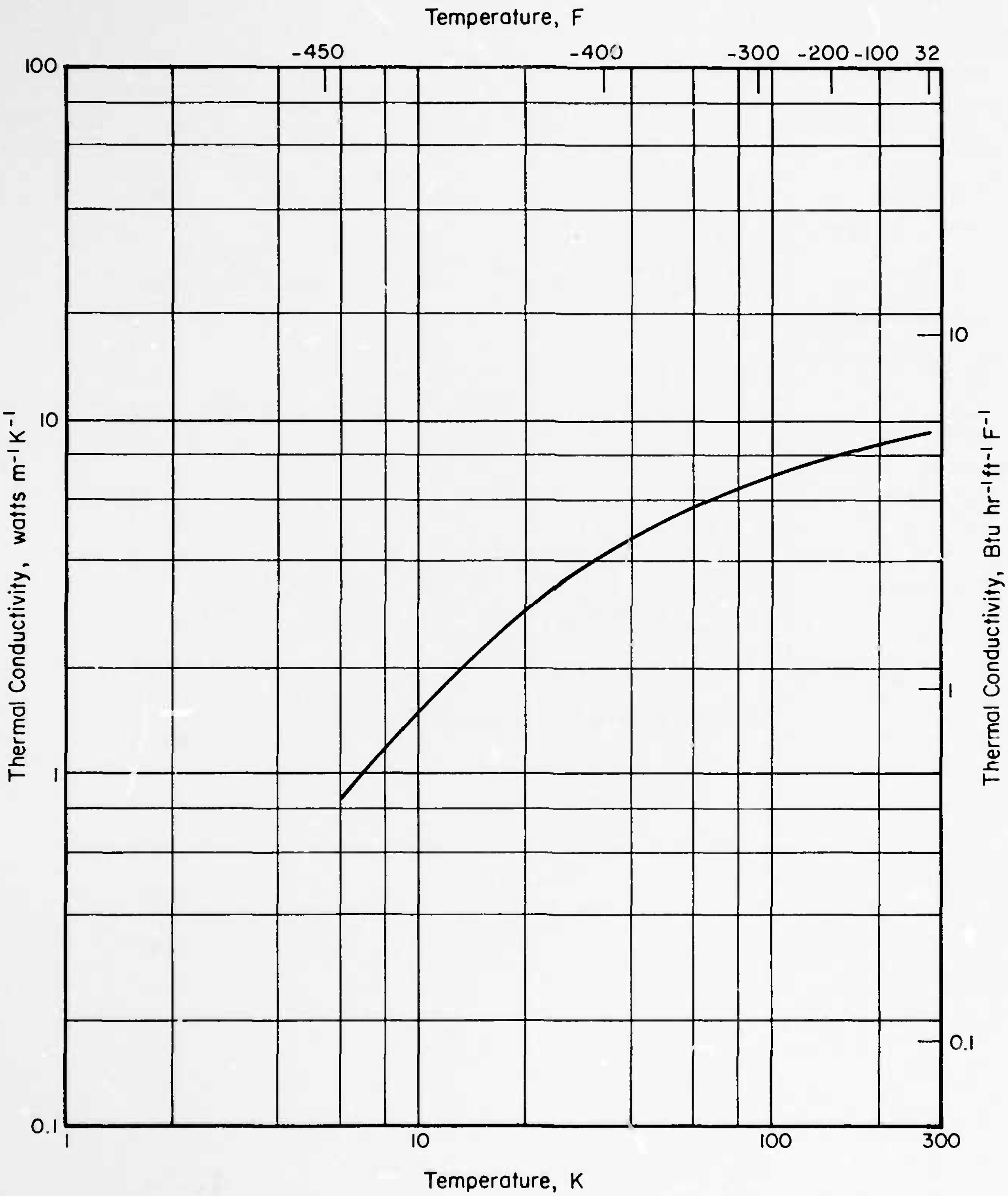
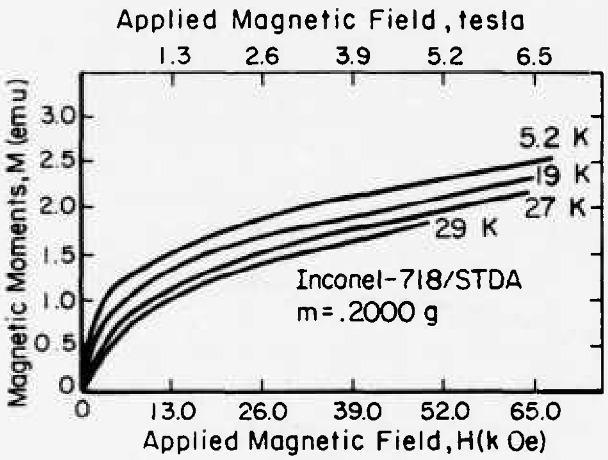


FIGURE 6.2.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR INCONEL 718 NICKEL ALLOY

42.5

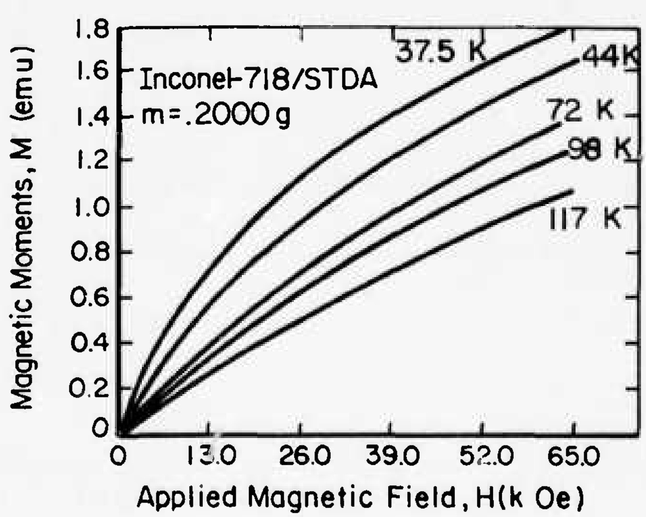
TABLE 6.2.3-MA1

Alloy Designation:	Inconel 718
Specification:	IN 718 STDA
Form:	Rod
Dimension, cm(in.):	Not given
Condition:	STDA: solution treated, double aged
Peak induction, B_s, at 4.2K:	0.1335T (tesla)
Curie TEmperature:	~130K (-225 F)



MAGNETIC MOMENT AS A FUNCTION OF EXTERNAL FIELD AT LOW TEMPERATURES

MAGNETIC MOMENT AS A FUNCTION OF EXTERNAL FIELD



Reference: 94206

Alloy Designation:	Inconel 718 Nickel-Base Alloy
Specification:	
Form:	Rod
Diameter, cm (in.):	0.37 (0.145)
Condition:	Solution annealed
Test Temperature:	4.2 K (-452 F)

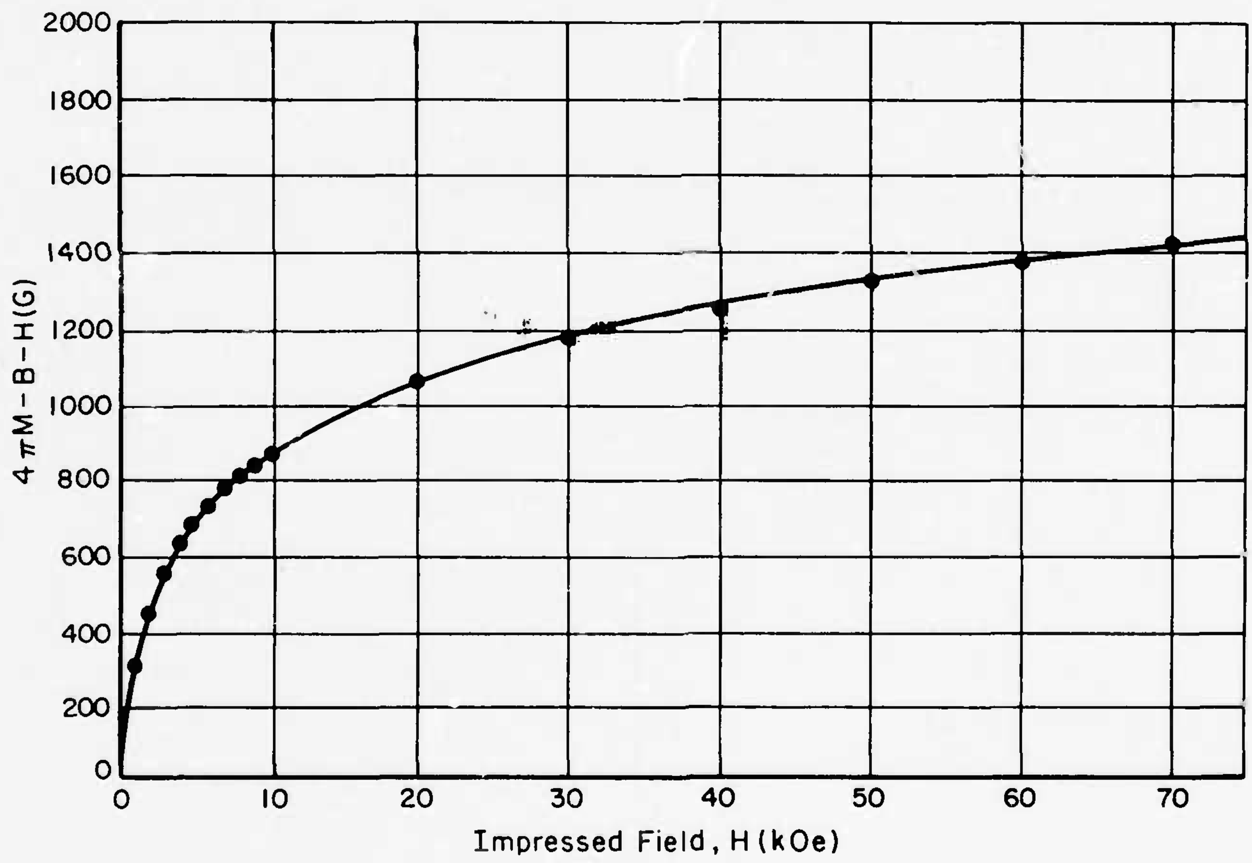


FIGURE 6.2.3-MA2. MAGNETIZATION VERSUS APPLIED MAGNETIC FIELD FOR INCONEL 718 NICKEL-BASE ALLOY [96871]

TABLE 6.2.4-ME1

Alloy Designation: Inconel 706 Nickel-Base Alloy

Specification:
Form: Forging
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1256 K (1800 F) 1 hr, AC, aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1263 (183.2)			1574 (228.3)		1673 (242.7)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1045 (151.6)			1203 (174.5)		1250 (181.3)
	Min						
Std. Deviation							
Elong, percent	Avg	23.6			28.7		30.2
	Min						
RA, percent	Avg	33.4			33.3		33.3
	Min						
No. of Spec. (No. of Heats)		2 (2)			2 (2)		2 (2)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1876 (272.1)			2175 (315.4)		2250 (326.3)
K_t = 10	Min						
No. of Spec. (No. of Heats)		2 (2)			2 (2)		2 (2)
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.4-ME2

Alloy Designation:	**Inconel 706 Nickel-Base Alloy**
Specification:	
Form:	Forging
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Solution treated 1255 K (1800 F) 1 hr, AC; aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F), AC

Testing Temperature, K (F)		297 (75)					4 (-452)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
J_{Ic} MN/m (in.-lb/$in.^2$)	Avg	0.064 (364)					0.106 (607)
	Min						
Orientation: —							
No. of Spec. (No. of Heats)		2 (1)					2 (1)
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 95168

(a) **Indicate specimen design and orientation for shear specimens:**
(b) **Indicate specimen design for K_{Ic} data:**

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TABLE 6.2.4-ME3

Alloy Designation:	**Inconel 706 Nickel-Base Alloy (Weld Metal)**
Specification:	
Form:	Forging-TIG welded, Alloy 718 filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment soltuion treated 1255 K (1800 F) 1 hr, AC; aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1111 (161.2)			1295 (187.8)		1370 (198.7)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1000 (145.0)			1174 (170.3)		1222 (177.2)
	Min						
Std. Deviation							
Elong, percent	Avg	1.7			3.8		4.0
	Min						
RA, percent	Avg	5.4			4.4		5.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1627 (236.0)			1757 (254.8)		1884 (273.2)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1					
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.4-ME4

Alloy Designation:	Inconel 706 Nickel-Base Alloy (Weld Metal)
Specification:	
Form:	Forging-TIG welded, Alloy 718 filler
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F) 1 hr, AC; aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F), AC, tested as aged

Testing Temperature, K (F)		297 (75)					4 (-452)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						58.7 (53.0)
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							(1)
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 95168

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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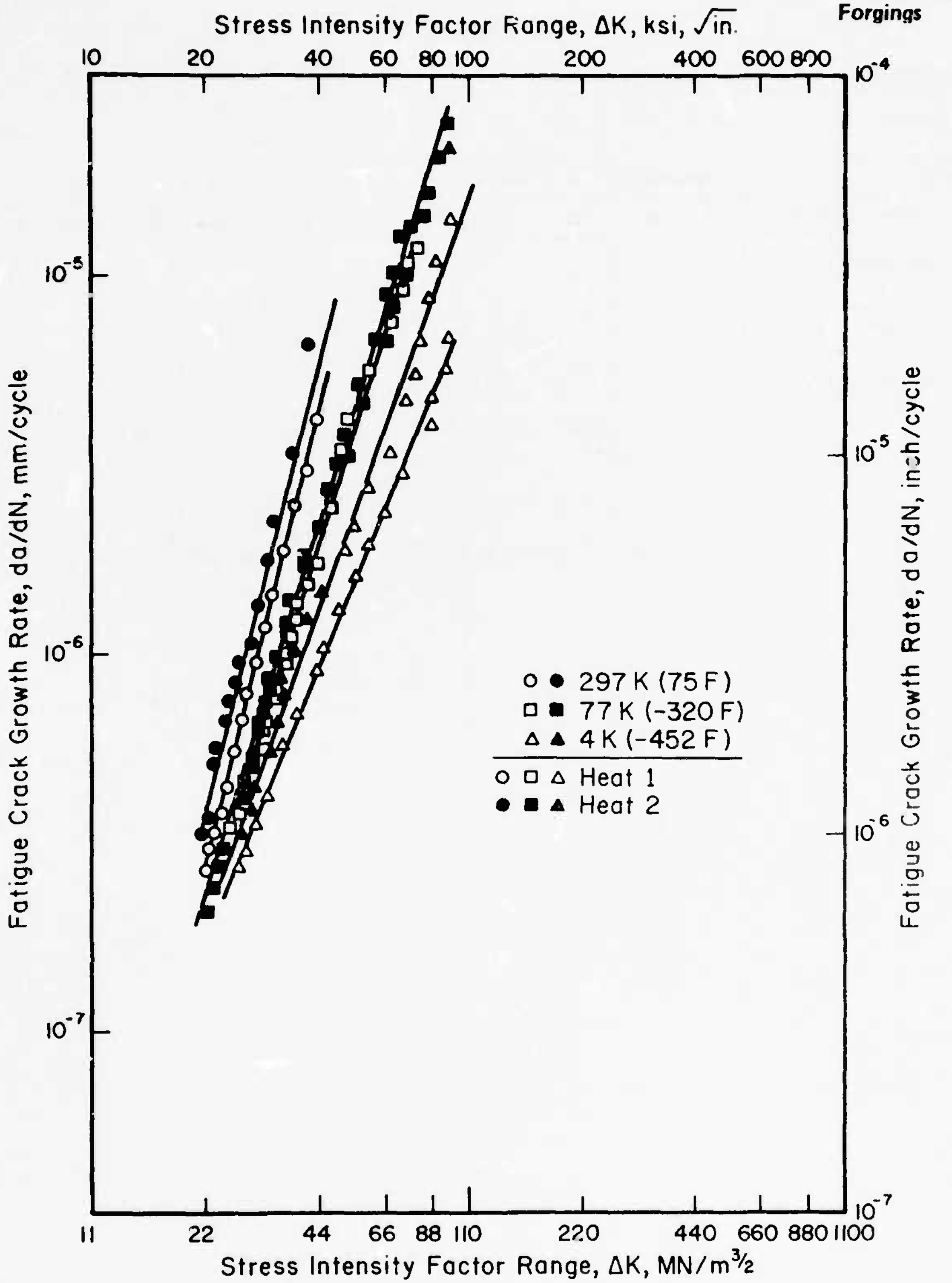

FIGURE 6.2.4-ME1. FATIGUE CRACK GROWTH RATE IN FORGINGS [OVER 5.080 cm (2.000 in.) DIAMETER] OF INCONEL 706 NICKEL-BASE ALLOY [Heat treatment: solution treated 1255 K (1800 F) 1 hr, AC, aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC] [95168]

TABLE 6.2.4-TR1

Alloy Designation: Inconel 706 Nickel Alloy

Specification:
Form:
Dimension:
Condition: Solution treated and double aged

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.194	-0.220	-0.227	-0.228	
No. of Spec.	2	2	2	2	2	
References: 95168						
Specific Heat						
Joules kg^{-1} K^{-1}	470	245	100*	9.60	3.70	1.52
Btu lb^{-1} F^{-1}	(0.112)	(5.86×10^{-2})	(2.39×10^{-2})*	(2.20×10^{-3})	(8.84×10^{-4})	(3.63×10^{-4})
No. of Spec.	2	2	0	2	2	2
References: 95168, 96888						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

* Extrapolated.

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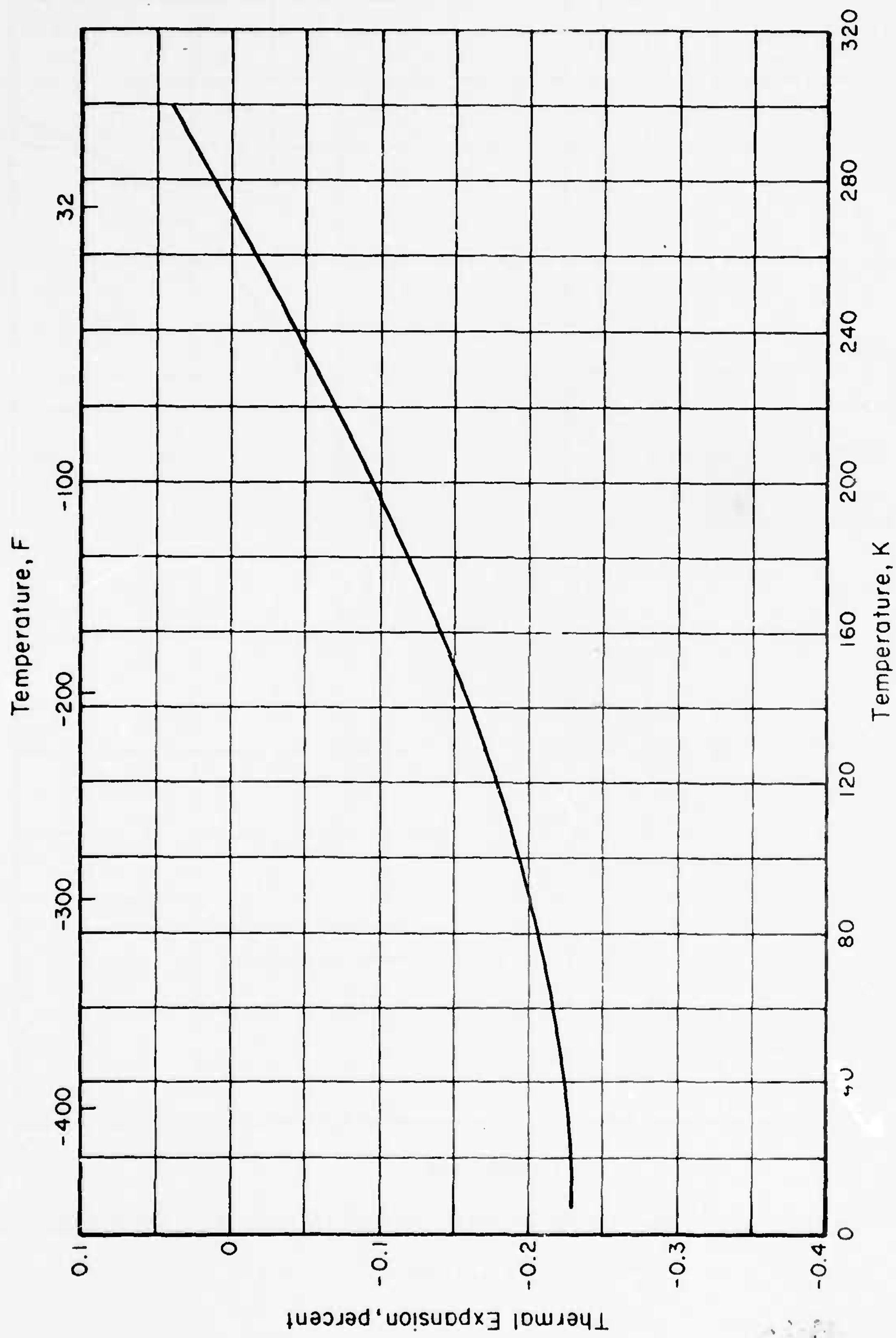

FIGURE 6.2.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INCONEL 706 NICKEL ALLOY

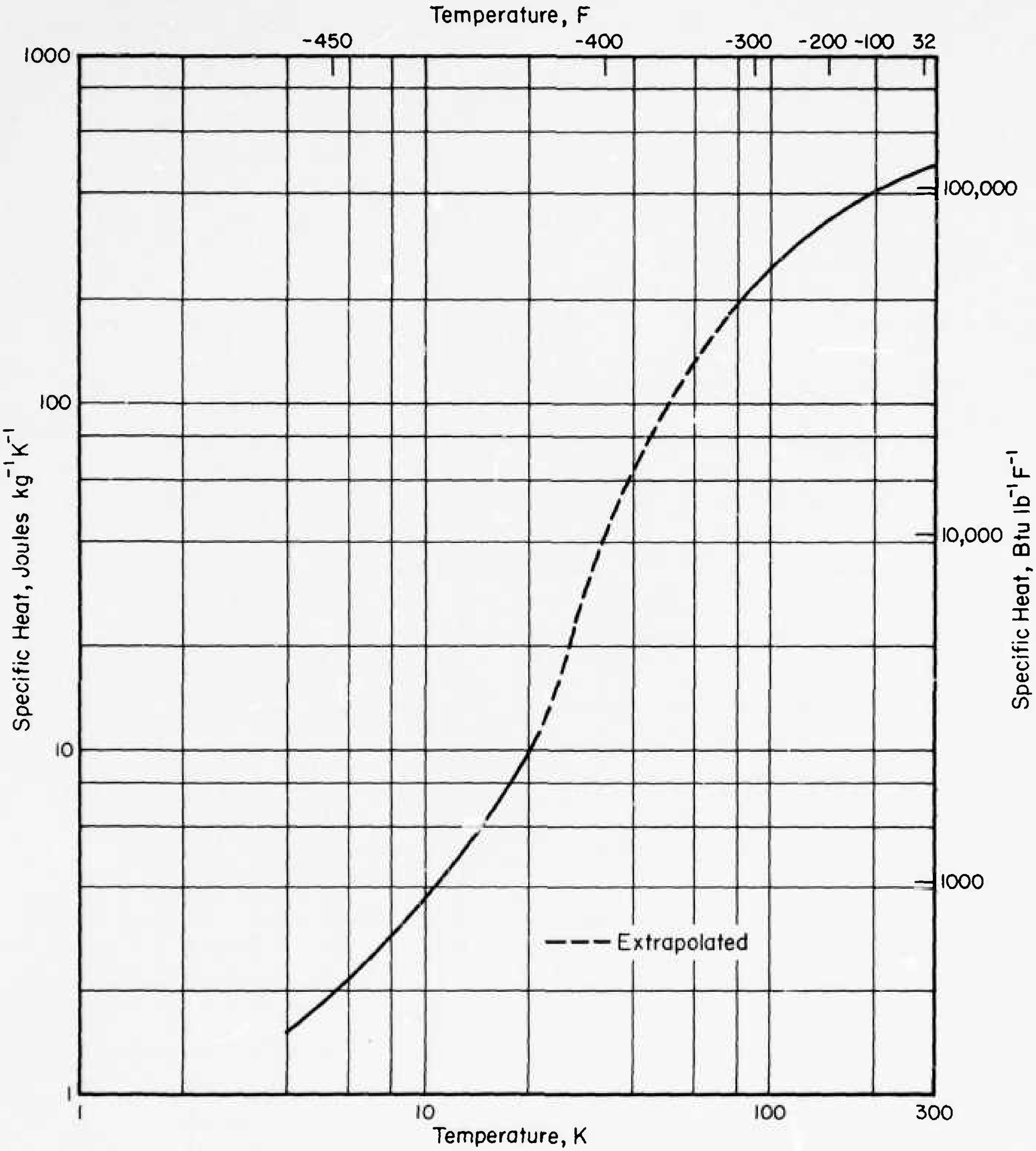

FIGURE 6.2.4-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR INCONEL 706 NICKEL ALLOY

TABLE 6.3.1-ME0.1

Alloy Designation:	**Invar 36 Controlled Expansion Alloy (Weld Metal)**
Specification:	
Form:	**Plate-TIG welded, Invar 36 filler**
Thickness, cm (in.):	**1.270 to 2.540 (0.500 to 1.000)**
Condition:	**Plate welded and tested as welded**

Testing Temperature, K (F)		297 (75)		155	(-180)			77	(-320)		
Compression, Longitudinal											
CYS, MN/m^2 (ksi)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
Compression, Transverse											
CYS, MN/m^2 (ksi)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
Shear(a)											
SUS, MN/m^2 (ksi)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
G, GN/m^2 (10^6 psi)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
Impact, Charpy V											
Long., Nm(ft-lb)	**Avg**	95	(70)	50	(37)			38	(28)		
	Min										
No. of Spec. (No. of Heats)		1		1				1			
Trans., Nm(ft-lb)	**Avg**										
	Min										
No. of Spec. (No. of Heats)											
Fracture Toughness(b)											
K_{Ic} $MN/m^{3/2}$($ksi\sqrt{in.}$)	**Avg**										
	Min										
Orientation: —											
No. of Spec. (No. of Heats)											
K_{IE}, $MN/m^{3/2}$($ksi\sqrt{in.}$)	**Avg**										
(From PTSC spec.)(—)	Min										
No. of Spec. (No. of Heats)											

References: 66001

(a) **Indicate specimen design and orientation for shear specimens:**
(b) **Indicate specimen design for K_{Ic} data:**

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TABLE 6.3.1-ME0.2

Alloy Designation:	**Invar 36 Controlled Expansion Alloy (Weld Metal)**
Specification:	
Form:	**Plate-TIG welded, Invar 36 filler**
Thickness, cm (in.):	**1.270 to 2.540 (0.500 to 1.000)**
Condition:	**Plate welded, weldment stress relieved 922 K (1200 F) 1½ hr, AC; tested as stress relieved**

Testing Temperature, K (F)		297 (75)	155 (-108)		77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	104 (77)	56 (41)		39 (29)		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 66001

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 6.3.3-ME5

Alloy Designation:	Inco Low-Expansion Alloy (unnamed)
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	627 (91)	993 (144)				
	Min	621 (90)	972 (141)				
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	359 (57)	655 (95)				
	Min	352 (51)	655 (95)				
Std. Deviation							
Elong, percent	Avg	44	37				
	Min	43	32				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	476 (69)	876 (127)				
K_t = 20	Min	448 (65)	848 (123)				
No. of Spec. (No. of Heats)		2	2				
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME6

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)				
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V*							
Long., Nm(ft-lb)	Avg	81.4 (60)	60.0 (44)				
	Min	77.3 (57)	--				
No. of Spec. (No. of Heats)		2	1				
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: --							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(--)	Min						
No. of Spec. (No. of Heats)							

References: 65184

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

* Half-size specimens

TABLE 6.3.3-ME7

Alloy Designation:	Inco Low-Expansion Alloy (unnamed)
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Annealed + Aged 922-936 K (1200-1225 F) 8-16 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1138 (165)	1558 (226)				
	Min	951 (138)	1531 (222)				
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	910 (132)	1213 (176)				
	Min	834 (121)	1165 (169)				
Std. Deviation							
Elong, percent	Avg	20	20				
	Min	16	11				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6	6				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1138 (165)	1365 (198)				
K_t = 20	Min	1082 (157)	1310 (190)				
No. of Spec. (No. of Heats)		6	6				
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME8

Alloy Designation:	Inco Low-Expansion Alloy (unnamed)
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Annealed + Aged 922-936 K (1200-1225 F) 8-16 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V*							
Long., Nm(ft-lb)	Avg	24.0 (17.7)	15.9 (11.7)	16.3 (12)			
	Min	16.3 (12)	14.9 (11)	14.9 (11)			
No. of Spec. (No. of Heats)		10	6	4			
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 65184

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

* Half-size specimens

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TABLE 6.3.3-ME9

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed 1255 K (1800 F) 0.5 hr., AC + aged 950-964 K (1250-1275 F) 4 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1062 (154)	1434 (208)				
	Min	1048 (152)	1393 (202)				
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	814 (118)	1117 (162)				
	Min	800 (116)	1103 (160)				
Std. Deviation							
Elong, percent	Avg	24	21				
	Min	22	14				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1027 (149)	1282 (186)				
K_t = 20	Min	1020 (148)	1276 (185)				
No. of Spec. (No. of Heats)		2	2				
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME10

Alloy Designation:	Inco Low-Expansion Alloy (unnamed)
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Annealed 1255 K (1800 F) 0.5 hr., AC + aged 950-964 K (1250-1275 F) 4hr.

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V*							
Long., Nm(ft-lb)	Avg	28.5 (21)	20.3 (15)	20.3 (15)			
	Min	27.1 (20)	19.0 (14)	20.3 (15)			
No. of Spec. (No. of Heats)		4	2	2			
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 65184

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

* Half-size specimens

TABLE 6.3.3-ME11

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1255 K (1300 F) 1 hr., AC; aged 936 K (1225 F) 8 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	314.4 (145.6)	1317 (191.0)	1339 (194.2)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	918.4 (133.2)	1207 (175.0)	1282 (185.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	1.0	1.9	0.7			
	Min						
RA, percent	Avg	6.0	3.5	3.8			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1368 (198.4)	1641 (238.0)	1615 (234.3)			
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208G

TABLE 6.3.3-ME11.1

Alloy Designation: Inco Low Expansion Alloy (Unnamed)

Specification:
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Solution treated 1255 K (1800 F) 1 hr, AC; aged 936 K (1225 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)					4 (-452)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
J_{Ic} MN/m (in.-lb/in.^{2})	Avg	0.046 (263)					0.034 (195)
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 95168

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 6.3.3-ME12

Alloy Designation:	Inco Low-Expansion Alloy (unnamed)
Specification:	
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	Annealed 1255 K (1800 F) 0.5 hr., AC; aged 936 K (1225 F) 8 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1234 (179)	1648 (239)				
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	896 (130)	1338 (194)				
	Min						
Std. Deviation							
Elong, percent	Avg	19	20				
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1689 (245)	2151 (312)				
K_t =	Min						
No. of Spec. (No. of Heats)		1	1				
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-TR1

Alloy Designation: Inco Controlled-Expansion Alloy

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	11.6		6.30		1.34		1.20		0.54			
Btu hr^{-1} ft^{-1} F^{-1}		(6.71)		(3.64)		(0.775)		(0.694)		(0.312)		
No. of Spec.	1		1		1		1		1			
References: 94206												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.068		-0.081		-0.083		-0.083			
No. of Spec.	1		1		1		1		1			
References: 94206												
Specific Heat												
Joules kg^{-1} K^{-1}									2.95		1.12	
Btu lb^{-1} F^{-1}										(0.000705)		(0.000268)
No. of Spec.									1		1	
References: 94206												
Electrical Resistivity												
Ohm m	94×10^{-8}		76×10^{-8}		71.5×10^{-8}		70×10^{-8}		70×10^{-8}			
Ohm circular mil ft^{-1}		(565)		(457)		(430)		(421)		(421)		
No. of Spec.	1		1		1		1		1			
References: 94206												

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INCO LEA
Plate

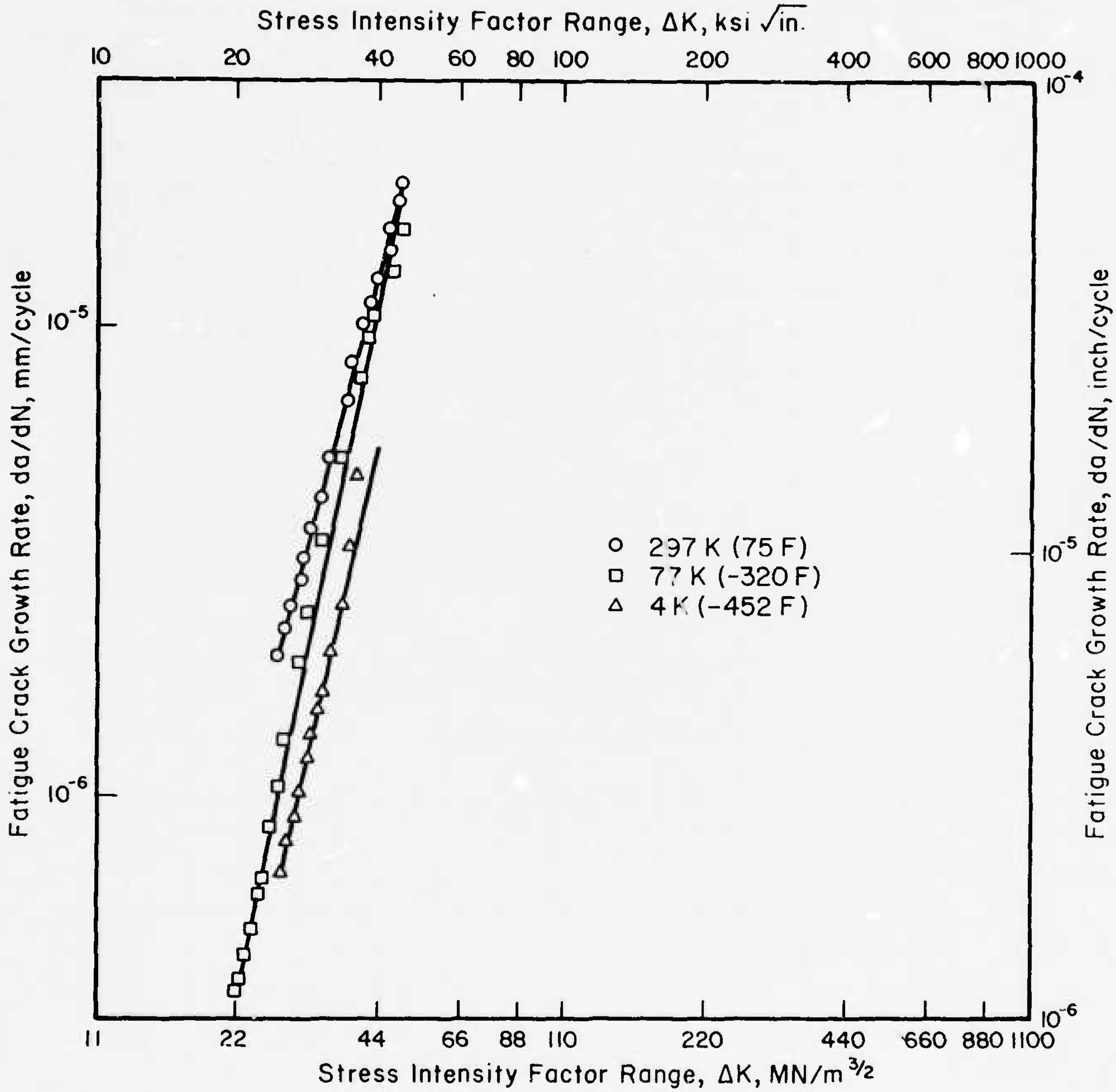

FIGURE 6.3.3-ME1. FATIGUE CRACK GROWTH RATE OF 7.6 cm (3 in.) THICK INCO LEA PLATE [Heat treatment: solution treated 1.255 K (1800 F) 1 hr, AC; aged 936 K (1225 F) 8 hr, AC]

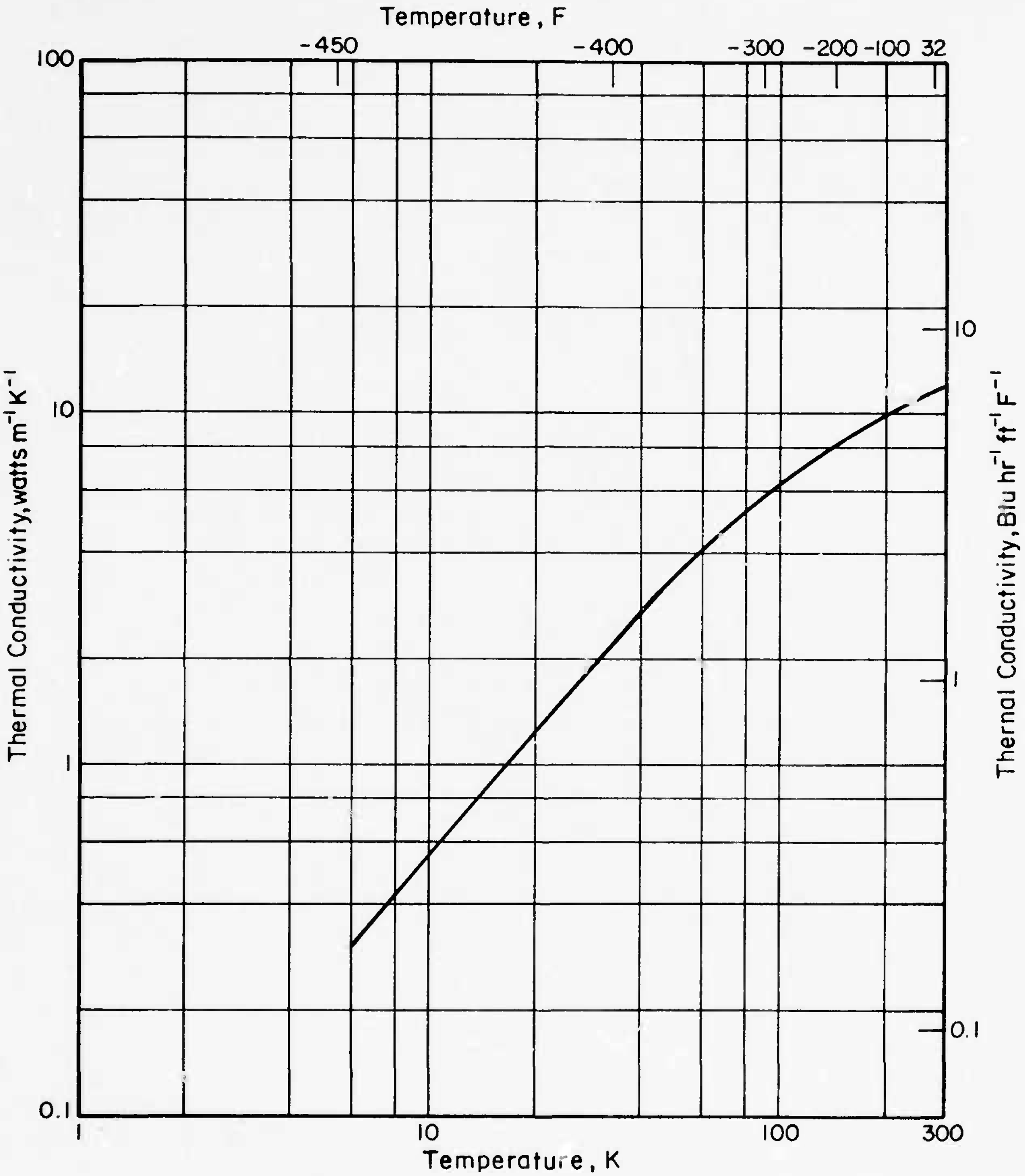

FIGURE 6.3.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR INCO CONTROLLED EXPANSION ALLOY

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High Purity Nickel
Bar

TABLE 6.4.1-ME1

Alloy Designation: Nickel-High Purity (99.99%)

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Hot-finished

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	366.1 (53.1)			492.9 (71.5)		734.3 (106)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	173.1 (25.1)			219.3 (31.8)		225.5 (3.27)
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 or 3 (1)			2 or 3 (1)		2 or 3 (1)
E, GN/m^2 (10^6 psi)	Avg	206.8 (30.0)			222.7 (32.3)		224.0 (32.5)
	Min						
No. of Spec. (No. of Heats)		2 or 3 (1)			2 or 3 (1)		2 or 3 (1)
Poisson's Ratio		0.310			0.310		0.303
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 89543

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TABLE 6.4.1-TR1

Alloy Designation:	High Purity Nickel
Specification:	
Form:	
Dimensions:	
Condition:	Annealed

Testing Temperature, K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
RRR-2500 Watts m^{-1} K^{-1}	94		165		380		1650		2600		2000	
Btu hr^{-1} ft^{-1} F^{-1}		(54.4)		(95)		(220)		(954)		(1500)		(1160)
RRR-670 Watts m^{-1} K^{-1}	94		165		380		1530		1670		960	
Btu hr^{-1} ft^{-1} F^{-1}		(54.4)		(95)		(220)		(885)		(966)		(555)
RRR-208 Watts m^{-1} K^{-1}	94		160		340		710		610		265	
Btu hr^{-1} ft^{-1} F^{-1}		(54.4)		(92)		(197)		(410)		(353)		(153)
RRR-80 Watts m^{-1} K^{-1}	94		160		335		365		217		87	
Btu hr^{-1} ft^{-1} F^{-1}		(54.4)		(92)		(194)		(211)		(126)		(50.3)
RRR-27 Watts m^{-1} K^{-1}	88		140		200		185		101		44	
Btu hr^{-1} ft^{-1} F^{-1}		(50.9)		(81)		(116)		(107)		(58.4)		(25.4)
No. of Spec.	—		2		4		4		5		5	
References: 26638, 90170, 90224, 90447												
Thermal Expansion (T_{273} to T)												
Longitudinal												
Percent	0		-0.175		-0.196		-0.199		-0.199		-0.199	
No. of Spec.	1		1		1		1		1		1	
References: 90208												
Specific Heat												
Joules kg^{-1} K^{-1}	429		232		68.2		5.80		1.62		0.503	
Btu lb^{-1} F^{-1}		(0.103)		(5.54×10^{-2})		(1.63×10^{-2})		(1.39×10^{-3})		(3.87×10^{-4})		(1.20×10^{-4})
No. of Spec.	1		1		1		1		1		4	
References: 42219, 90370, 96884												
Electrical Resistivity(1)												
RRR-3000 Ohm m	6.20×10^{-8}		1.00×10^{-8}		1.52×10^{-9}		1.11×10^{-10}		3.60×10^{-11}		2.07×10^{-11}	
Ohm circular mil ft^{-1}		(37.3)		(6.02)		(0.914)		(6.68×10^{-2})		(2.17×10^{-2})		(1.25×10^{-2})
RRR-1000 Ohm m	6.21×10^{-8}		1.01×10^{-8}		1.56×10^{-9}		1.52×10^{-10}		7.20×10^{-11}		6.20×10^{-11}	
Ohm circular mil ft^{-1}		(37.4)		(6.08)		(0.938)		(9.14×10^{-2})		(4.33×10^{-2})		(3.73×10^{-2})
RRR-300 Ohm m	6.22×10^{-8}		1.02×10^{-8}		1.71×10^{-9}		2.97×10^{-10}		2.12×10^{-10}		2.07×10^{-10}	
Ohm circular mil ft^{-1}		(37.4)		(6.14)		(1.03)		(0.179)		(0.128)		(0.125)
RRR-100 Ohm m	6.26×10^{-8}		1.06×10^{-8}		2.13×10^{-9}		7.16×10^{-10}		6.27×10^{-10}		6.26×10^{-10}	
Ohm circular mil ft^{-1}		(37.7)		(6.38)		(1.28)		(0.431)		(0.377)		(0.377)
RRR-30 Ohm m	6.41×10^{-8}		1.21×10^{-8}		3.64×10^{-9}		2.23×10^{-9}		2.14×10^{-9}		2.14×10^{-9}	
Ohm circular mil ft^{-1}		(38.6)		(7.28)		(2.19)		(1.34)		(1.29)		(1.29)
RRR-10 Ohm m	6.89×10^{-8}		1.69×10^{-8}		8.39×10^{-9}		6.96×10^{-9}		6.89×10^{-9}		6.89×10^{-9}	
Ohm circular mil ft^{-1}		(41.4)		(10.2)		(5.05)		(4.20)		(4.14)		(4.14)
No. of Spec.												
References: 90217												

(1) Interpolated from original data using theoretical correlations.

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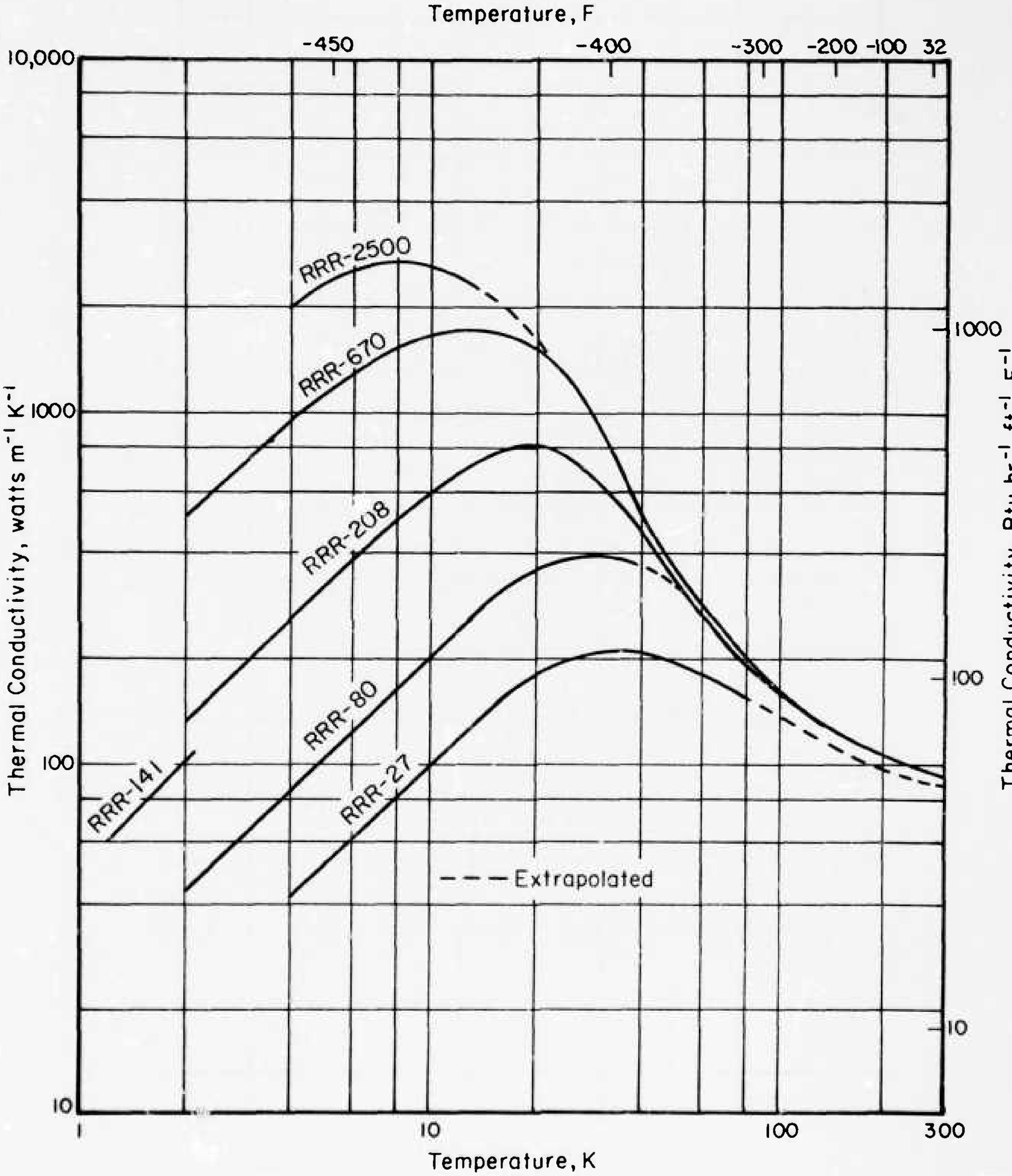

FIGURE 6.4.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

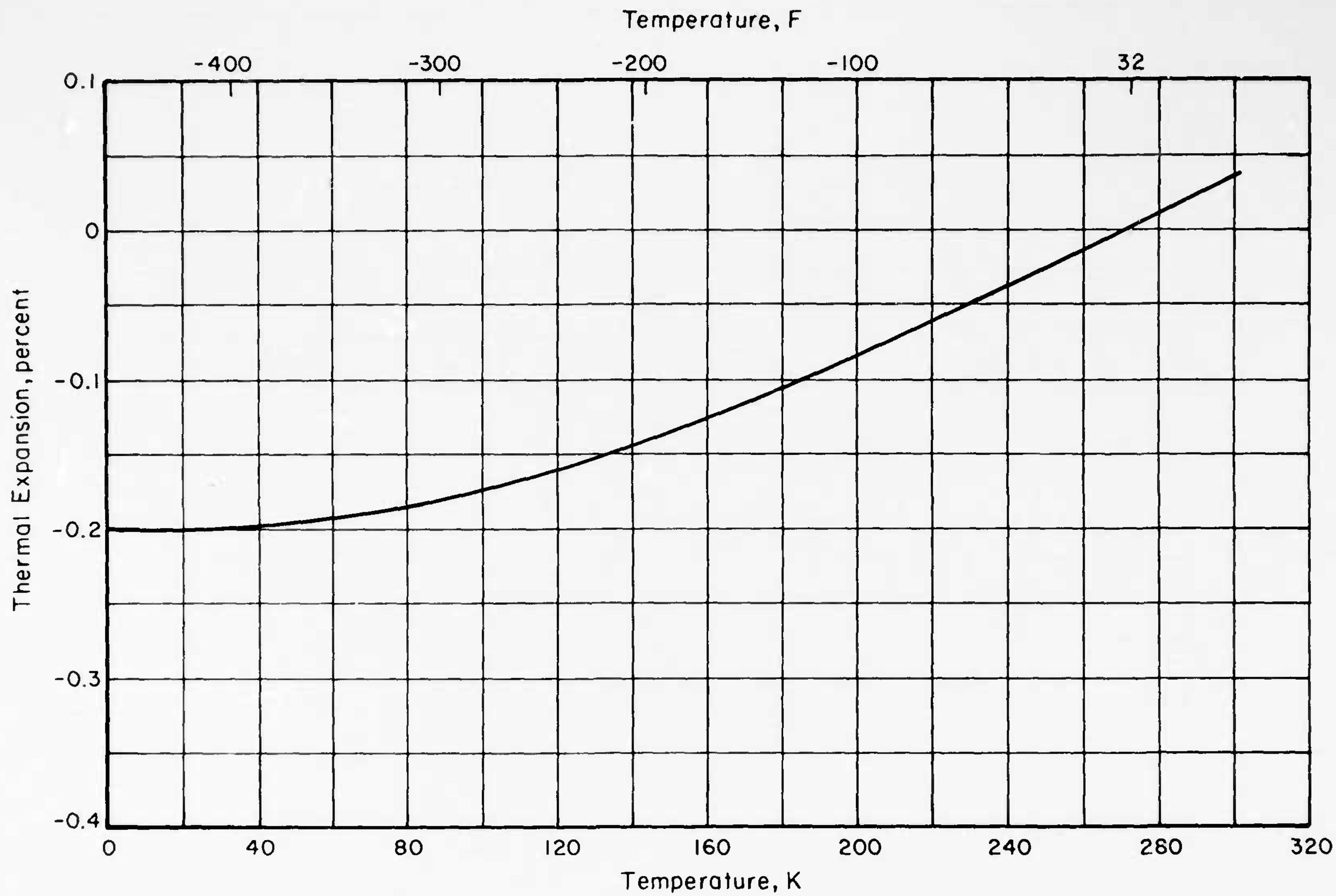

FIGURE 6.4.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FCR HIGH PURITY NICKEL

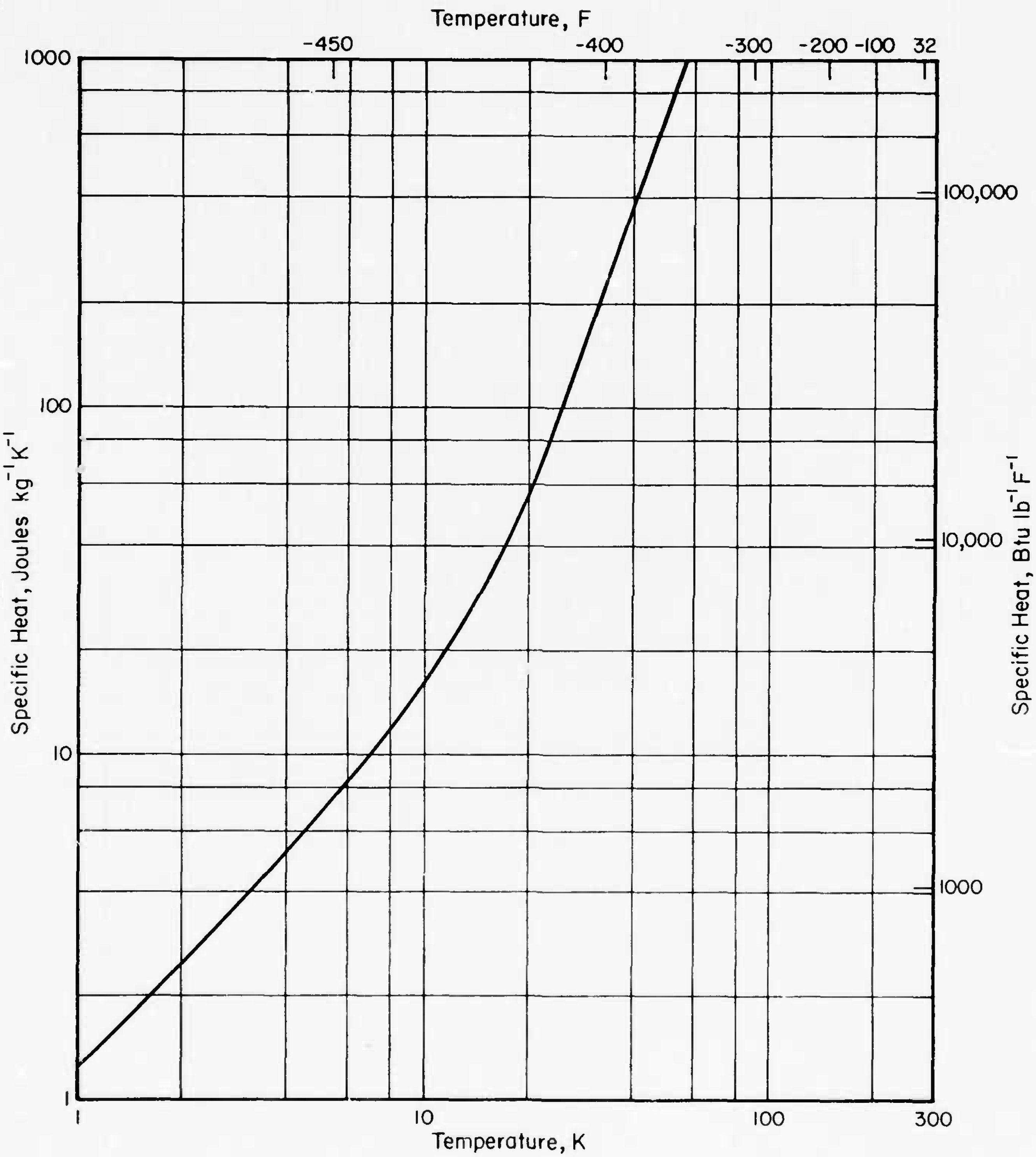

FIGURE 6.4.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

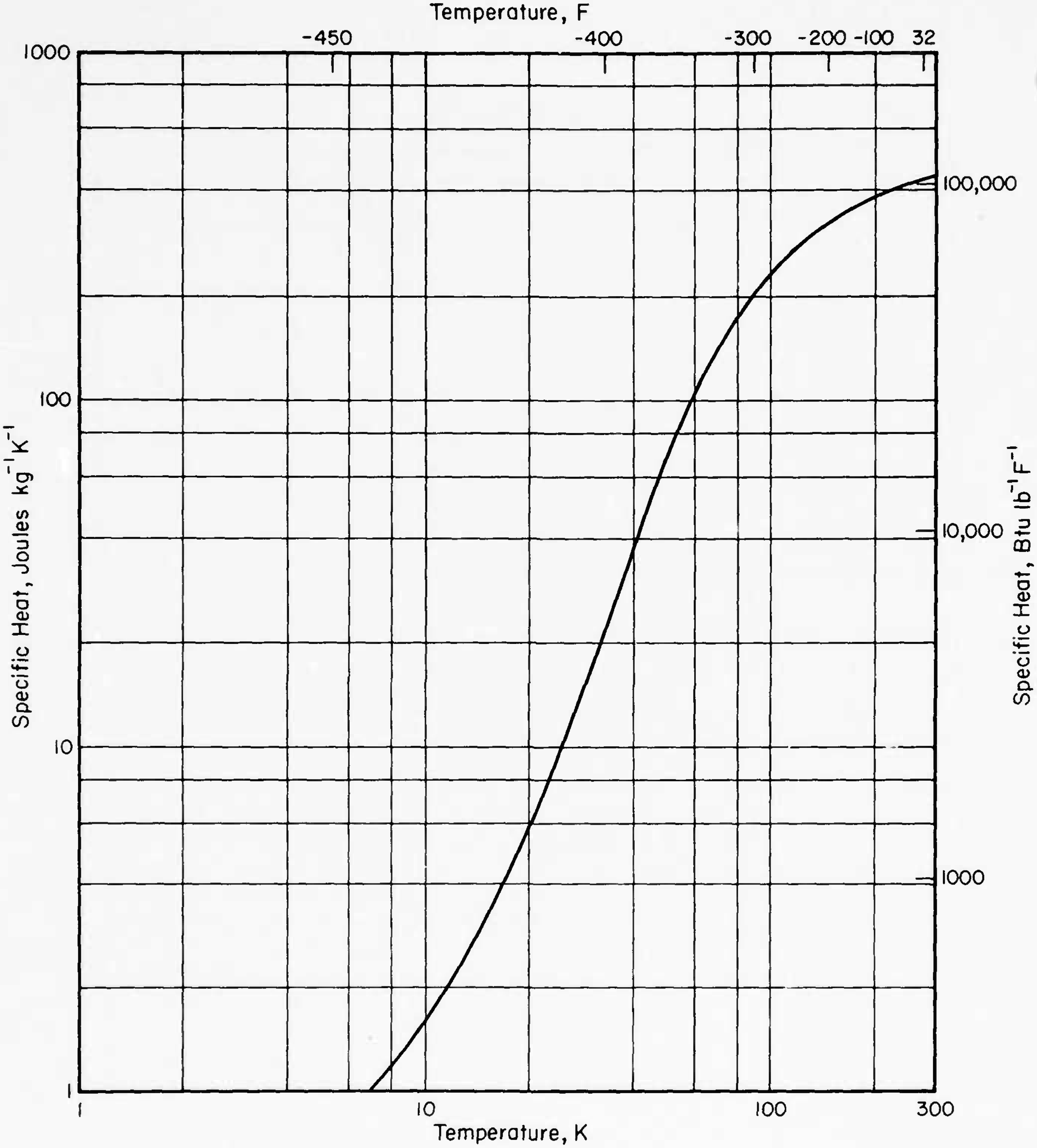

FIGURE 6.4.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

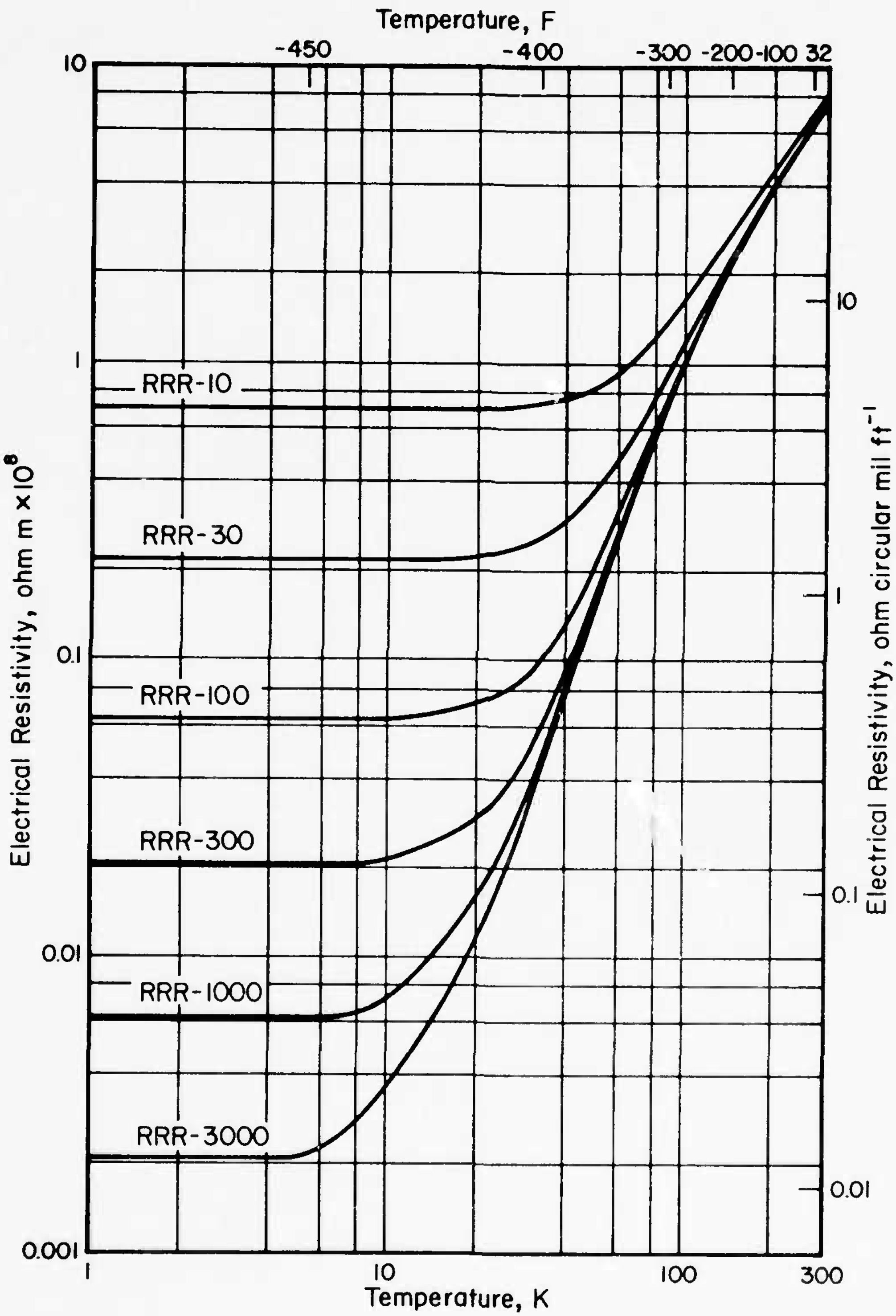

FIGURE 6.4.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

TABLE 6.4.2-ME1

Alloy Designation:	"A" Nickel
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	430 (62)				738 (107)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	97 (14)				230 (33)	
	Min						
Std. Deviation							
Elong, percent	Avg	43.4				36.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1				1	
E, GN/m^2 (10^6 psi)	Avg	200 (29)				230 (33)	
	Min						
No. of Spec. (No. of Heats)		1				1	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49048

TABLE 6.4.2-ME2

Alloy Designation: "A" Nickel

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	439 (63.7)	488 (70.8)		641 (93.0)	771.5 (111.9)	
	Min	432 (62.7)	482 (69.9)		636 (92.2)	768.1 (111.4)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	144 (20.9)	152 (22.0)		197 (28.5)	265 (38.4)	
	Min	141 (20.4)	145 (21.1)		196 (28.4)	157 (37.3)	
Std. Deviation							
Elong, percent	Avg	48.4	50.3		61.2	59.2	
	Min	47.8	48.8		60.7	59.1	
RA, percent	Avg	66.2	65.6		75.2	67.8	
	Min	66.2	63.5		74.3	67.5	
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 54986

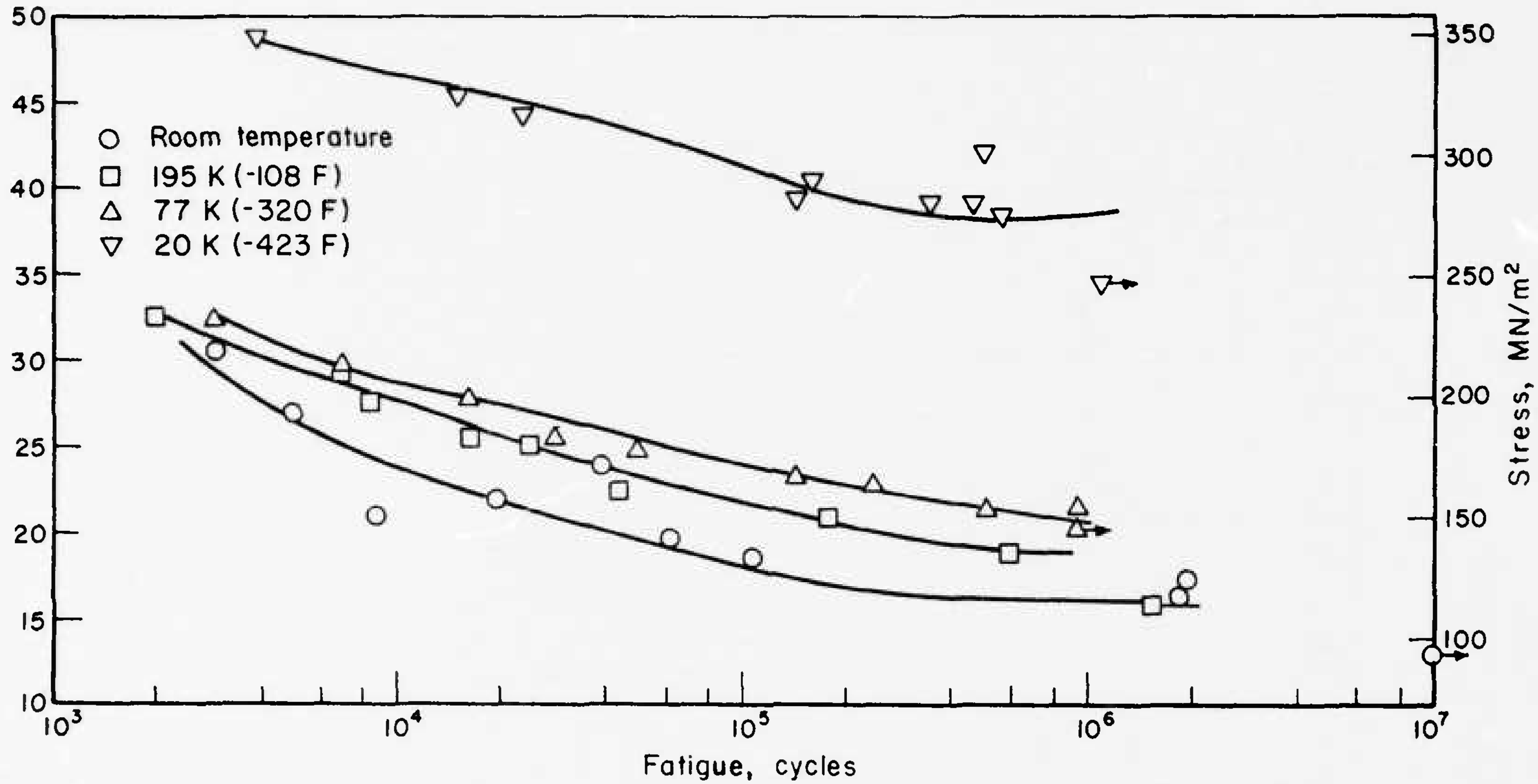

FIGURE 6.4.2-ME1. FATIGUE LIFE CURVES FOR FLEXURAL LOADING ON NOTCHED (K_T = 3.0) AND UNNOTCHED SPECIMENS OF ANNEALED "A" NICKEL 0.053 cm (0.021 in.) THICK [49048]

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TABLE 6.4.2-TR1

Alloy Designation: "A" Nickel

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}					51.0		25.0					
Btu hr^{-1} ft^{-1} F^{-1}						(29.5)		(14.5)				
No. of Spec.					1		1					
References:												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.178		-0.200		-0.205					
No. of Spec.	1		1		2		2					
References: 48134, 90366												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												
(1) 99.4 Ni, as forged.												

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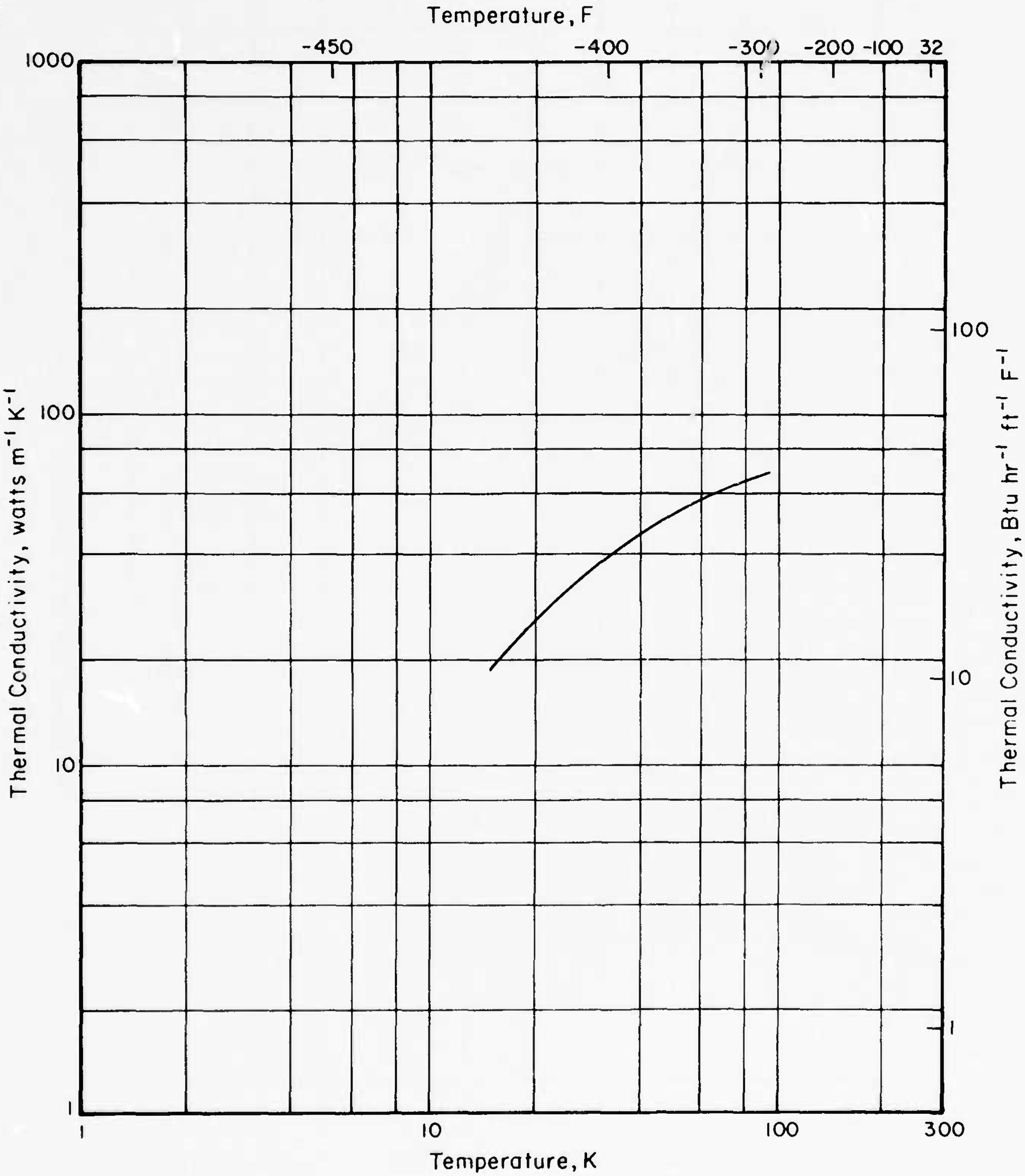

FIGURE 6.4.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR NICKEL "A"

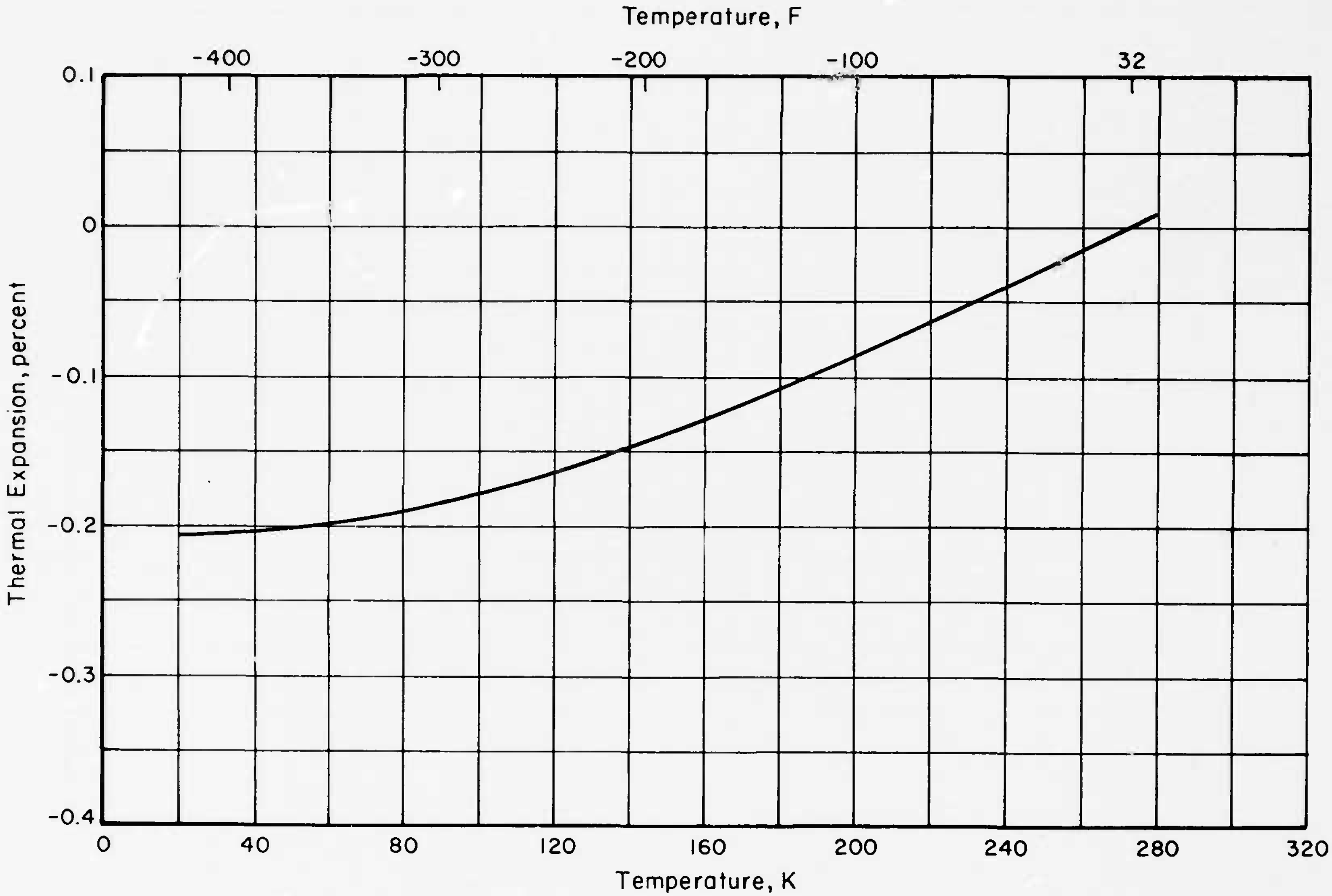

FIGURE 6.4.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR NICKEL "A"

INDEX TO MATERIAL CODES FOR SECTION 7.0

ALLOY STEELS

MATERIALS	MATERIAL CODE
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18Ni (200) MARAGING	7.1.2
1010 STEEL	7.3.1
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Fe (47-50) Ni	7.4.4

TABLE 7.1.1-ME1

Alloy Designation:	9Ni Steel
Specification:	ASTM A553-I
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	1075 K (1475 F), WQ; 840-1080 K (1050-1125 F), ac or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	415 (60)			450 (65)		
Loading frequency Hz						
with R = -1 and K_t = 3.1						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)	195 (28)			175 (25)		
Loading frequency Hz						
with R = -1 and K_t = 3.1						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 92996

TABLE 7.1.1-ME2

Alloy Designation:	9Ni Steel
Specification:	ASTM A553-I
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	1075 K (1475 F), WQ; 840-1080 K (1050-1125 F), AC or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	365 (53)			455 (66)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)	255 (37)			360 (52)		
Loading frequency Hz						
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 92996

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TABLE 7.1.1-ME3

Alloy Designation: 9Ni Steel

Specification: ASTM A353
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	882 (128)		1190 (172)	1503 (218)	1590 (231)	
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg	558 (81.0)		1010 (146)	1096 (159)	1430 (208)	
	Min						
Std. Deviation							
Elong, percent	Avg	17.3		29.6	11.5	21.2	
	Min						
RA, percent	Avg			66.8		59.1	
	Min						
No. of Spec. (No. of Heats)		(1)		1	(1)	1	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49048, 91494

TABLE 7.1.1-ME4

Alloy Designation:	9Ni Steel
Specification:	ASTM A353
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)					4 (-452)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						87 (73)
	Min						
Orientation T – L							
No. of Spec. (No. of Heats)							1
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 91494

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME5

Alloy Designation: 9Ni Steel

Specification: ASTM A353
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Double normalized at 1175 K (1650 F), and 1060 K (1450 F), and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297	(75)	195	(-108)	77	(-320)	20	(-423)		
Fatigue, Axial Loading										
S_N at 10^5 cycles, MN/m^2(ksi)										
Loading frequency Hz										
with R = and K_t =										
No. of S-N Curves (No. of Heats)										
Ratio S_N/TUS at 10^5 cycles										
S_N at 10^6 cycles, MN/m^2(ksi)										
Loading frequency Hz										
with R = and K_t =										
No. of S-N Curves (No. of Heats)										
Ratio S_N/TUS at 10^6 cycles										
S_N at 10^7 cycles, MN/m^2(ksi)										
Loading frequency Hz										
with R = and K_t =										
No. of S-N Curves (No. of Heats)										
Ratio S_N/TUS at 10^7 cycles										
Fatigue, Flexural Loading										
S_N at 10^5 cycles, MN/m^2(ksi)	407	(59)	448	(65)	448	(65)	400	(58)		
Loading frequency Hz										
with R = -1 and K_t = 3.1										
No. of S-N Curves (No. of Heats)	1	(1)	1	(1)	1	(1)	1	(1)		
S_N at 10^6 cycles, MN/m^2(ksi)	255	(37)	317	(46)	255	(37)	255	(37)		
Loading frequency Hz										
with R = -1 and K_t = 3.1										
No. of S-N Curves (No. of Heats)	1	(1)	1	(1)	1	(1)	1	(1)		
S_N at 10^7 cycles, MN/m^2(ksi)										
Loading frequency Hz										
with R = and K_t =										
No. of S-N Curves (No. of Heats)										
Ratio S_N/TUS at 10^7 cycles										

References: 49048

TABLE 7.1.1-ME6

Alloy Designation:	9Ni Steel
Specification:	A553-I
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	1075 K (1475 F), WQ, 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	779 (113)	1172 (170)				
	Min	765 (111)	1158 (168)				
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	731 (106)	972 (141)				
	Min	724 (105)	--				
Std. Deviation							
Elong, percent	Avg	21					
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2(2)	2(2)				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88112, 92996

TABLE 7.1.1-ME7

Alloy Designation:	9Ni Steel
Specification:	A353
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	738 (107)	1164 (169)	1594 (231)			
	Min	724 (105)	--	--			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	634 (92.0)	847 (123)	1434 (208)			
	Min	617 (89.5)	--	--			
Std. Deviation							
Elong, percent	Avg	35.8	--	21.2			
	Min						
RA, percent	Avg	--	--	59.1			
	Min						
No. of Spec. (No. of Heats)		2(2)	1	1			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 92996, 94197

TABLE 7.1.1-ME8

Alloy Designation:	9Ni Steel
Specification:	ASTM a553-I
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	115 (85.1)			52.3 (38.7)		
	Min	100 (77)			43 (32)		
No. of Spec. (No. of Heats)		9 (1)			9 (1)		
Trans., Nm(ft-lb)	Avg	89.5 (66.3)			42.9 (31.8)		
	Min	80 (59)			35 (26)		
No. of Spec. (No. of Heats)		9 (1)			9 (1)		
Fracture Toughness[(b)]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 41531

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME9

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A553-I
Form: Plate-MIG Welded, Inco Weld A covered electrode
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Plate 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ; welded; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg				58.1 (43.0)*		
	Min						
No. of Spec. (No. of Heats)					>1		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 90537

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:
* A corresponding average Charpy-V impact value of 48.6 Nm (36.0 ft-lb) was measured for stress-relieved speciments of the same type.

TABLE 7.1.1-ME10

Alloy Designation: 9Ni Steel (Weld Metal)

Specification:	ASTM A553-I
Form:	Plate-Pulse MIG Welded, Inconel 92 filler alloy
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Plate 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ; Welded; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	718.4 (104.2)			885.3 (128.4)		
	Min	699.1 (101.4)					
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			1		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88112

TABLE 7.1.1-ME11

Alloy Designation:	9Ni Steel (Weld Metal)
Specification:	ASTM A553-I
Form:	Plate-shielded MIG welded, Incoweld B filler alloy
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Plate 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ; welded; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	718.4 (104.2)			919.1 (133.3)		
	Min	690.9 (100.2)			896.3 (130.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 88112

TABLE 7.1.1-ME12

Alloy Designation: 9Ni Steel

Specification: ASTM A353
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	109 (80.8)			45.6 (33.7)		
	Min	106 (78)			37 (27)		
No. of Spec. (No. of Heats)		6 (1)			6 (1)		
Trans., Nm(ft-lb)	Avg	91.4 (67.5)			37.6 (27.8)		
	Min	85 (63)			32 (24)		
No. of Spec. (No. of Heats)		6 (1)			6 (1)		
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 41531

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME13

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A353
Form: Plate-MIG welded, Incoweld A covered electrode
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Plate, Double Normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F); welded; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg				47.9 (35.5)*		
	Min						
No. of Spec. (No. of Heats)					>1		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 90537

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:
* A corresponding averages Charpy-V impact value of 59.4 Nm (44.0 ft-lb) was measured for stress-relieved specimens of the same type.

TABLE 7.1.1-ME14

Alloy Designation:	9Ni Steel	
Specification:	A553-I	
Form:	Plate	
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)	
Condition:	1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ	

Testing Temperature, K (F)		297 (75)		173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	772 (112)		917 (133)	972 (141)	1151 (167)	
	Min	710 (103)				1062 (154)	
Std. Deviation		31.5 (4.57)				57 (8.3)	
TYS, MN/m^2 (ksi)	Avg	710 (103)		834 (121)	862 (125)	986 (143)	
	Min	590 (86.1)				841 (122)	
Std. Deviation		38.6 (5.60)				82.1 (11.9)	
Elong, percent	Avg	28.0		17.9	17.9	24.4	
	Min	20.0				20.4	
RA, percent	Avg	66.7		43.9	42.3	37.6	
	Min	49.0				--	
No. of Spec. (No. of Heats)		39 (7)		4 (2)	4 (2)	12 (5)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 76974, 92996

TABLE 7.1.1-ME15

9Ni Steel
Plate

Alloy Designation:	9Ni Steel
Specification:	A553-I
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	1075 K (1475 F), WQ, 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)	77 (-320)				
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	153 (113)	71.4 (52.9)				
	Min		39.3 (29)				
No. of Spec. (No. of Heats)		1	12 (5)				
Trans., Nm(ft-lb)	Avg	107 (79)	34.3 (25.4)				
	Min		30 (22)				
No. of Spec. (No. of Heats)		1	7 (2)				
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 41531, 92996, 96686, 96700

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 7.1.1-ME16

Alloy Designation:	9Ni Steel
Specification:	A 353
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297	(75)		173	(-150)	123	(-240)	77	(-320)	20	(-423)
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	772	(112)		906.7	(131.5)	979	(142)	1179	(171)	1390	(202)
	Min	710	(103)						1089	(158)	1330	(193)
Std Deviation		35.8	(4.90)						--			
TYS, MN/m^2 (ksi)	Avg	624	(90.5)		782.6	(113.5)	834	(121)	945	(137)	1210	(175)
	Min	498	(72.2)						793	(115)	1140	(166)
Std Deviation		52.8	(7.66)						--			
Elong, percent	Avg	29.1			16.9		16.9		23.3		18.0	
	Min	23.0							18.3		9	
RA, percent	Avg	68.8			59.7		61.0		56.0		39.6	
	Min	64.0							--		7	
No. of Spec. (No. of Heats)		16	(7)		4	(2)	4	(2)	11	(4)	5	(1)
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg	945	(137)								1310	(190)
K_t = 6.4	Min	938	(136)								1210	(176)
No. of Spec. (No. of Heats)		5	(1)								5	(1)
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg											
	Min											
Std Deviation												
TYS, MN/m^2 (ksi)	Avg											
	Min											
Std Deviation												
Elong, percent	Avg											
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 64373, 76974, 92996

TABLE 7.1.1-ME17

Alloy Designation:	9Ni Steel
Specification:	A353
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297	(75)		163	(-165)	77	(-320)		
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear[(a)]										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., Nm(ft-lb)	Avg	157	(116)		74	(55)	47.1	(34.9)		
	Min						36.6	(27.0)		
No. of Spec. (No. of Heats)		1			1		8	(5)		
Trans., Nm(ft-lb)	Avg	130	(95)				41	(30)		
	Min	1					1			
No. of Spec. (No. of Heats)										
Fracture Toughness[(b)]										
K_{Ic} $MN/m^{3/2}$ ($ksi\sqrt{in.}$)	Avg									
	Min									
Orientation —										
No. of Spec. (No. of Heats)										
K_{IE}, $MN/m^{3/2}$ ($ksi\sqrt{in.}$)	Avg									
(From PTSC spec.)(—)	Min									
No. of Spec. (No. of Heats)										

References: 41531, 91978, 92996

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 7.1.1-ME18

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	539 (78.2)			613 (88.9)		
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles	0.66			0.75		
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	495 (71.8)					
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1					
Ratio S_N/TUS at 10^7 cycles	0.61					
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	225 (32.7)			402 (58.3)		
with R = -1 and K_t = 7.1						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles	0.28			0.49		
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	221 (32.0)					
with R = -1 and K_t = 7.1						
No. of S-N Curves (No. of Heats)	1					
Ratio S_N/TUS at 10^7 cycles	0.27					

References: 76974

TABLE 7.1.1-ME19

Alloy Designation: 9Ni Steel

Specification: ASTM A353
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	578 (83.9)			608 (88.2)		
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles	0.70			0.74		
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	544 (78.9)					
with R = -1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1					
Ratio S_N/TUS at 10^7 cycles	0.66					
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	245 (35.6)			466 (67.6)		
with R = -1 and K_t = 7.1						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles	0.30			0.57		
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency 60. Hz	235 (34.1)					
with R = -1 and K_t = 7.1						
No. of S-N Curves (No. of Heats)	1					
Ratio S_N/TUS at 10^7 cycles	0.29					

References: 76974

TABLE 7.1.1-ME20

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A353
Form: Plate-MIG welded, Incoweld A covered electrode
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate-Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F); welded; tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb) Avg				89 (66)*		
Min				81 (60)		
No. of Spec. (No. of Heats)				>1		
Trans., Nm(ft-lb) Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.) Avg						
Min						
Orientation —						
No. of Spec. (No. of Heats)						
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.) Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90537

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:
* A corresponding average Charpy-V impact value of 99 Nm (73 ft-lb) was measured for stress-relieved specimens.

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TABLE 7.1.1-ME21

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A353
Form: Plate-MIG welded, Inconel 92, filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate-Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F); welded; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg				134 (99)*		
	Min				130 (96)		
No. of Spec. (No. of Heats)					>1		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 90537

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:
* A corresponding average Charpy-V impact value of 130 Nm (96 ft-lb) was measured for stress-relieved specimens.

TABLE 7.1.1-ME22

Alloy Designation:	9Ni Steel
Specification:	A553–I
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	1075 K (1475 F),WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)		123 (-240)	108 (-265)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	765 (111)		1007 (146)	1034 (150)	1124 (163)	
	Min	710 (103)		924 (134)	965 (140)	1062 (154)	
Std. Deviation		30.1 (4.36)				--	
TYS, MN/m^2 (ksi)	Avg	710 (103)		910 (132)	924 (134)	1000 (145)	
	Min	650 (94)		820 (119)	841 (122)	940 (134)	
Std. Deviation		40.5 (5.87)				--	
Elong, percent	Avg	25.7		--	--	26.0	
	Min	22.0		--	--	--	
RA, percent	Avg	73.5		--		--	
	Min	72.0		--		--	
No. of Spec. (No. of Heats)		15(6)		3(3)	4(4)	5(4)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 91978, 92996

TABLE 7.1.1-ME23

Alloy Designation:	9Ni Steel
Specification:	A553-I
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297	(75)		123	(-240)	108	(-265)	77	(-320)	
Compression, Longitudinal											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Compression, Transverse											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Shear(a)											
SUS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Impact, Charpy V											
Long., Nm(ft-lb)	Avg	132	(97.8)		102	(75.6)	92.5	(68.5)	70.2	(52.0)	
	Min	127	(94.1)		70.1	(51.9)	68.0	(50.4)	49.0	(36.3)	
No. of Spec. (No. of Heats)		2	(2)		3	(3)	4	(4)	5	(5)	
Trans., Nm(ft-lb)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Fracture Toughness(b)											
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg										
	Min										
Orientation: —											
No. of Spec. (No. of Heats)											
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg										
(From PTSC spec.)(—)	Min										
No. of Spec. (No. of Heats)											

References: 91978, 92996

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME24

Alloy Designation:	9Ni Steel
Specification:	A 353
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297	(75)		123	(-240)	108	(-265)	77	(-320)	
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	752	(109)		1076	(156)	1090	(158)	1160	(168)	
	Min	682	(98.9)		1091	(151)	1020	(148)	1090	(158)	
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	647	(93.9)		862	(125)	841	(122)	917	(133)	
	Min	498	(72.2)		834	(121)	717	(104)	793	(115)	
Std. Deviation											
Elong, percent	Avg	23.7			--		--		--		
	Min										
RA, percent	Avg				--		--		--		
	Min										
No. of Spec. (No. of Heats)		5	(4)		2	(2)	3	(3)	3	(2)	
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
Elong, percent	Avg										
	Min										
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)											
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 91978, 92996

TABLE 7.1.1-ME25

Alloy Designation:	**9Ni Steel**
Specification:	A 353
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	*Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)*

Testing Temperature, K (F)		297 (75)		123 (-240)	108 (-265)	77 (-320)	
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	109 (80.7)		102 (75.6)	70.7 (52.4)	53.3 (39.5)	
	Min			88.0 (65.2)	52.0 (38.5)	37.0 (27.4)	
No. of Spec. (No. of Heats)		1		2 (2)	4 (4)	4 (4)	
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 91978, 92996

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME26

Alloy Designation:	9Ni Steel
Specification:	A553-I
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)		108 (-265)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	758 (110)			1165 (169)		
	Min	710 (103)			1131 (164)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	628 (91.1)		834 (121)	869 (126)		
	Min	600 (87.0)			841 (122)		
Std. Deviation							
Elong, percent	Avg	31.7			30.0		
	Min	27.0			29.0		
RA, percent	Avg	66.0			--		
	Min	5 (5)		1	6 (6)		
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 91978, 92996, 96684

TABLE 7.1.1-ME27

Alloy Designation:	9Ni Steel
Specification:	A553-I
Form:	Plate
Thickness, cm (in.):	over 5,080 (2,000)
Condition:	1075 K (1475 F), WQ, 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)		108 (-265)	77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg			76.0 (56.3)	100 (74.4)		
	Min				66.0 (48.9)		
No. of Spec. (No. of Heats)				1	4 (4)		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
J_{Ic} KJ/m^2(in.-lb/in.^{2})	Avg			430 (75.3)	111 (19.4)		
	Min			422 (73.9)	76 (13.3)		
Orientation: –				>1	>1		
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 92296, 96684

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME28

Alloy Designation:	9Ni Steel
Specification:	ASTM A353
Form:	Bar
Diameter:	Up to 2.540 cm (1.000 in.)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	865 (125)	1010 (146)	1235 (179)	1509 (219)		
	Min	855 (124)	1005 (146)	1219 (177)	1501 (218)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	816 (118)	894 (130)	1101 (160)	1436 (208)		
	Min	808 (117)	880 (128)	1098 (159)	1423 (206)		
Std. Deviation							
Elong, percent	Avg	24.2	25.4	26.7	18.3		
	Min	23.8	25.1	25.7	13.5		
RA, percent	Avg	70.4	67.5	60.6	47.8		
	Min	70.3	67.3	59.6	36.9		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 54986

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TABLE 7.1.1-ME29

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I
Form: Forgings
Thickness, cm (in.): Over 5.080 (2.000)
Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)	123 (-240)	108 (-265)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	770 (112)	1060 (154)	1090 (158)	1210 (176)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	650 (94)	770 (112)	800 (116)	920 (133)		
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 91978

TABLE 7.1.1-ME30

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I
Form: Forgings
Thickness, cm (in.): Over 5.080 (2.000)
Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)	123 (-240)	108 (-265)	77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	150 (111)	130 (96)	130 (96)	120 (89)		
	Min						
No. of Spec. (No. of Heats)		1	1	1	1		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 91978

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 7.1.1-ME31

Alloy Designation:	**9Ni Steel**
Specification:	**ASTM A353**
Form:	**Forgings**
Thickness, cm (in.):	**Over 5.080 (2.000)**
Condition:	**Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)**

Testing Temperature, K (F)		297 (75)		108 (-265)	77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg			66 (49)	73 (99)		
	Min			--	48 (65)		
No. of Spec. (No. of Heats)				1	2 (2)		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$($ksi\sqrt{in.}$)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$($ksi\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 91978

(a) **Indicate specimen design and orientation for shear specimens:**
(b) **Indicate specimen design for K_{Ic} data:**

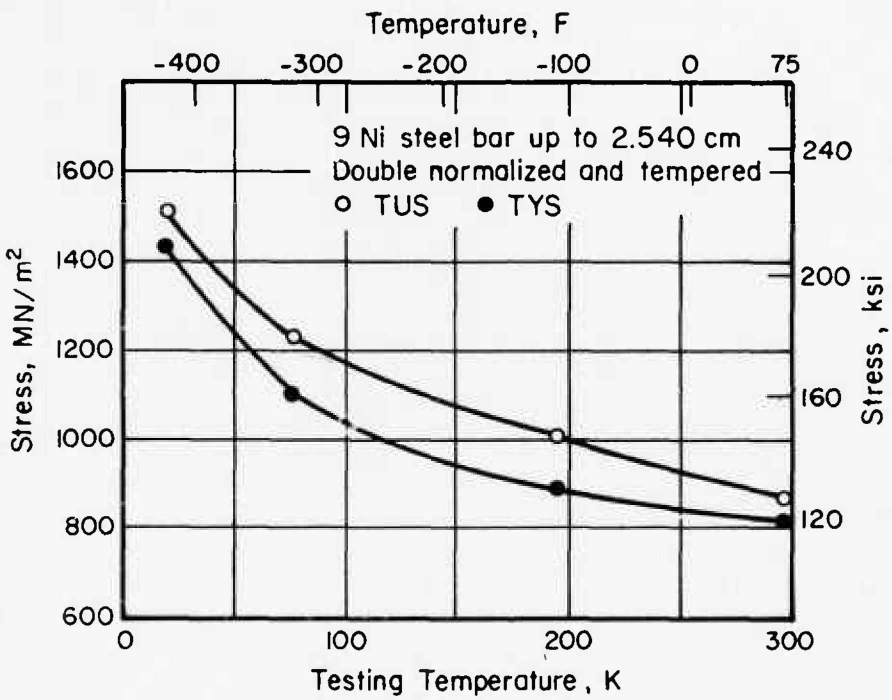

FIGURE 7.1.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 9Ni STEEL

49.3<

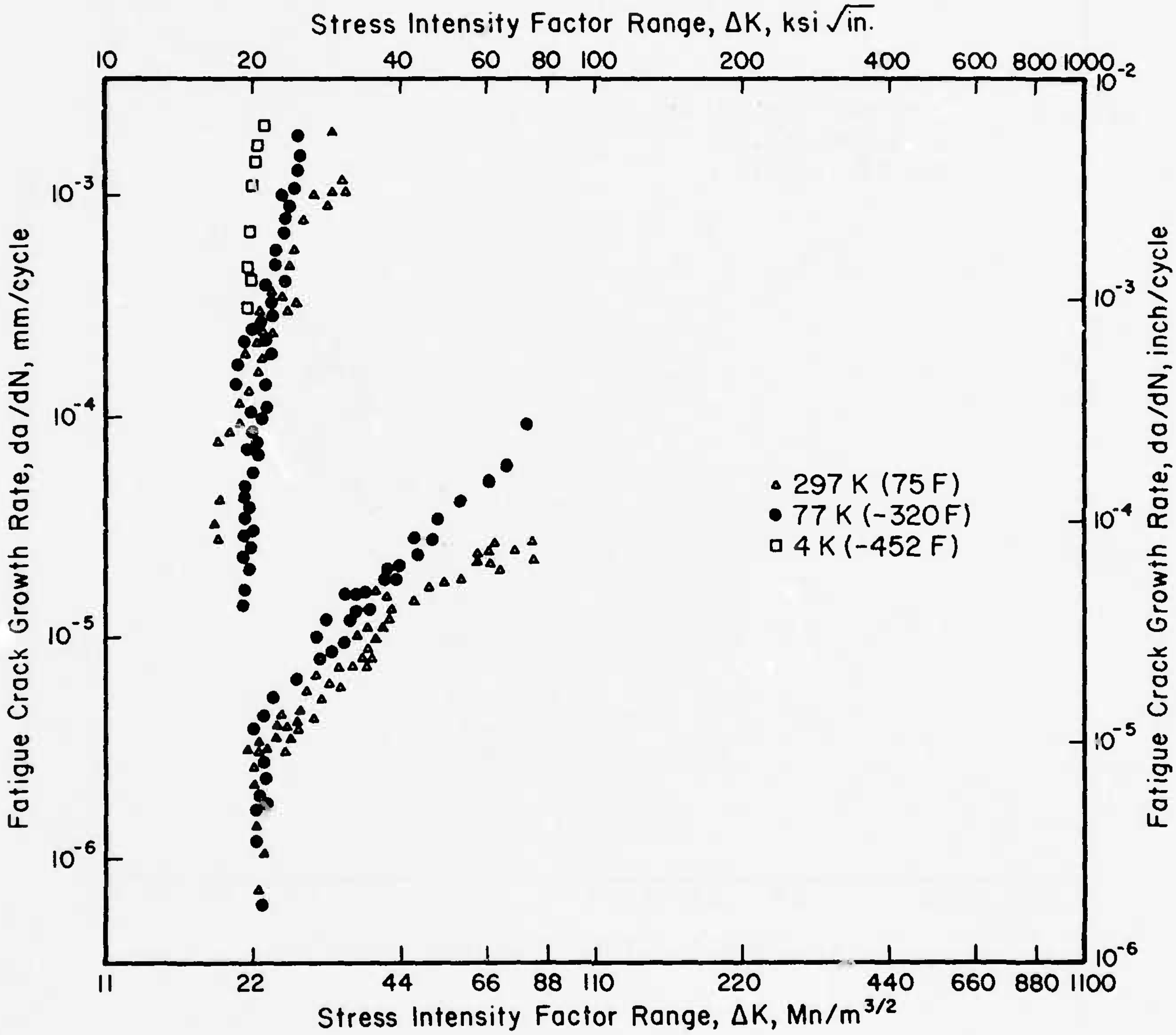

FIGURE 7.1.1-ME2. FATIGUE CRACK GROWTH RATES OF 9Ni STEEL (ASTM A553-I) AT 297, 77 AND 4 K(94208D)

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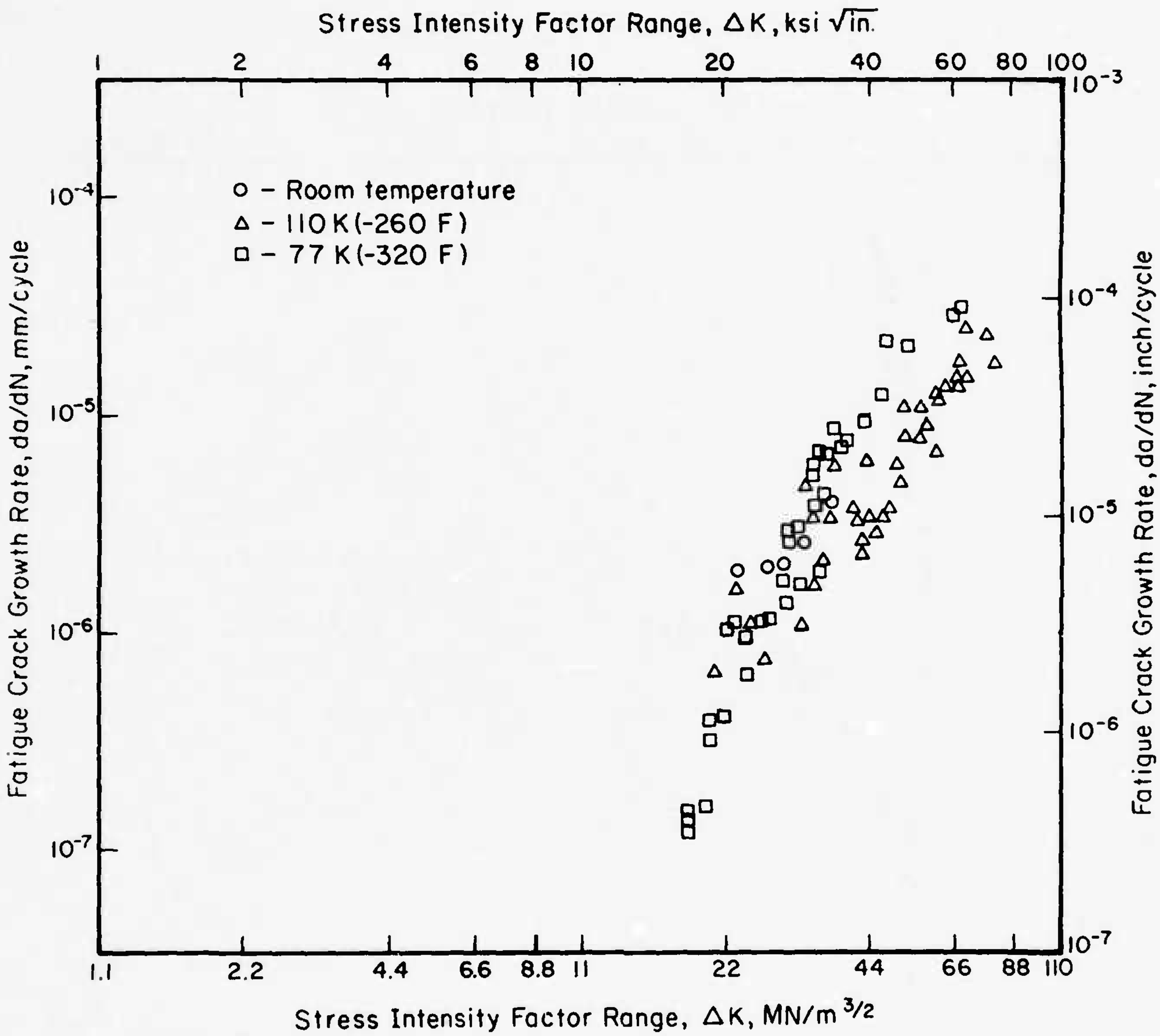

FIGURE 7.1.1-ME3. FATIGUE CRACK GROWTH RATE OF 9NI STEEL (ASTM 553-I) AT ROOM TEMPERATURE, 110 K (-261 F) and 77 K (-320 F) [96686]

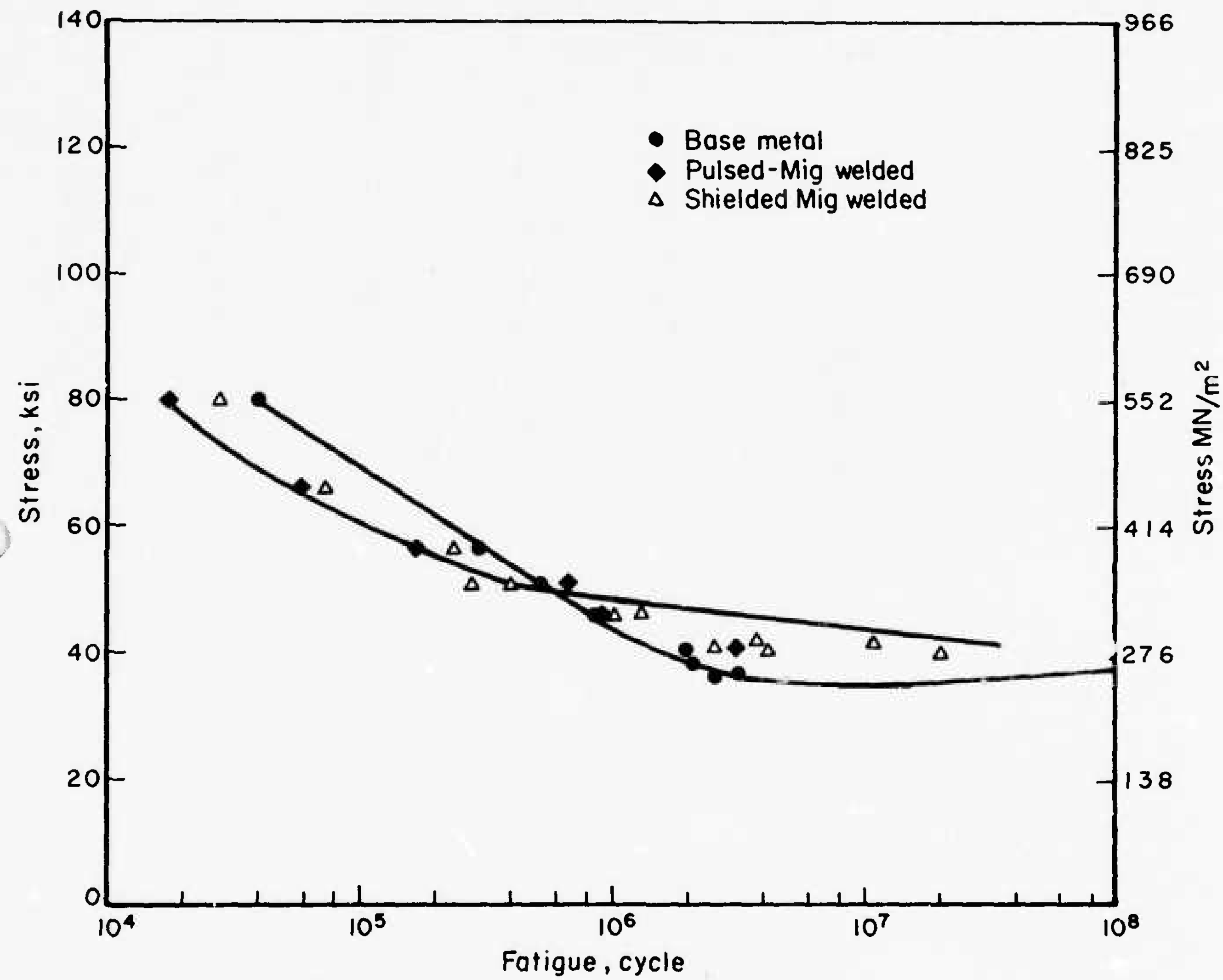

FIGURE 7.1.1-ME4. FATIGUE LIFE CURVES FOR FLEXURAL (ROTATING BEAM) LOADING ON 1.269 cm (0.25 in.)-THICK NOTCHED SPECIMENS OF WELDED AND UNWELDED 9NI STEEL AT 77 K (-320 F) [88112]

498<

TABLE 7.1.1-TR1

Alloy Designation: 9Ni Steel

Specification: ASTM A353
Form:
Dimension:
Condition: Double Normalized and Tempered

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	28.5		16.2									
Btu hr^{-1} ft^{-1} F^{-1}		(16.5)		(9.37)								
No. of Spec.	1		1									
References: 90537												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.16									
No. of Spec.	1		1									
References: 90537												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

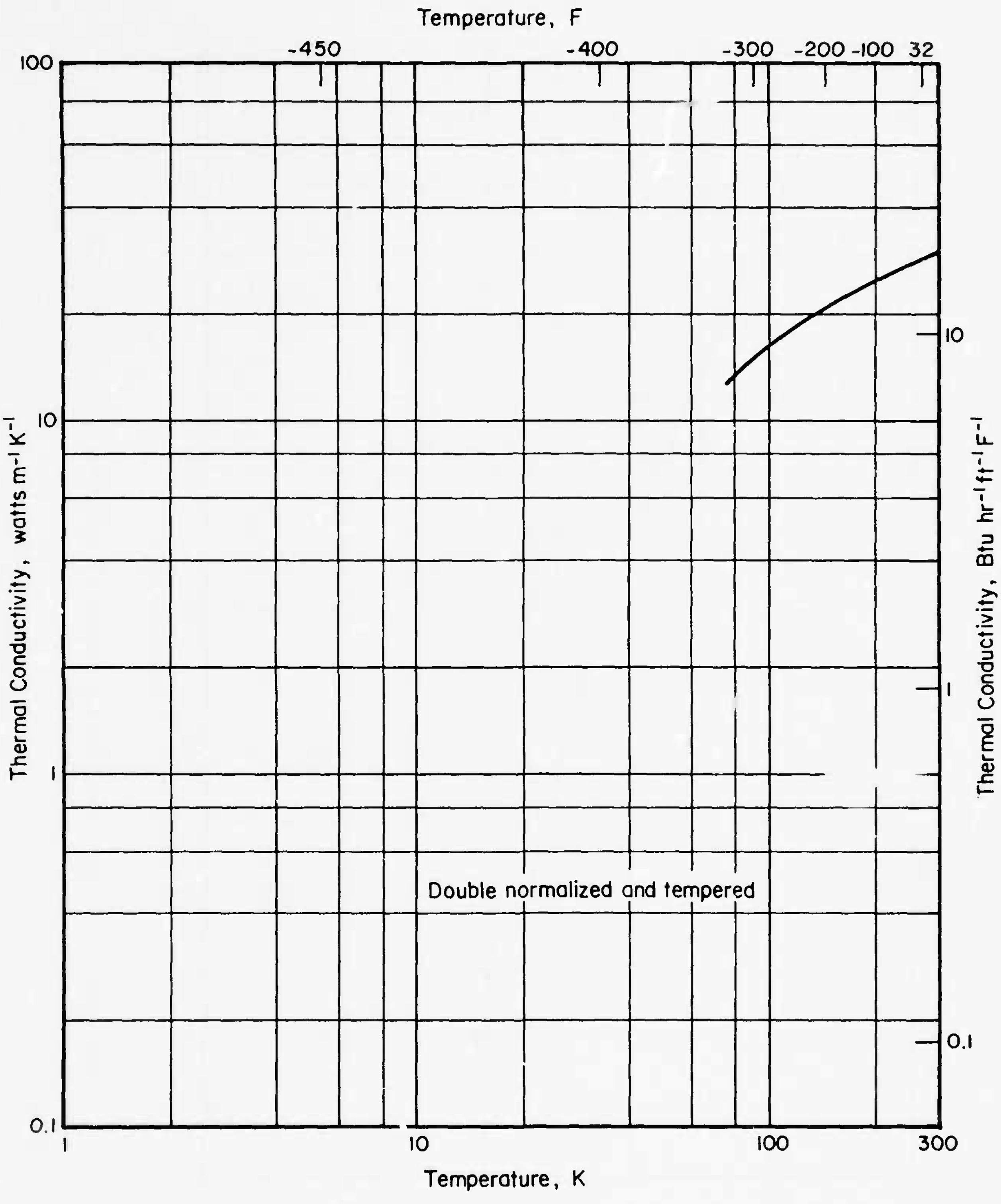

FIGURE 7.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR 9-Ni STEEL

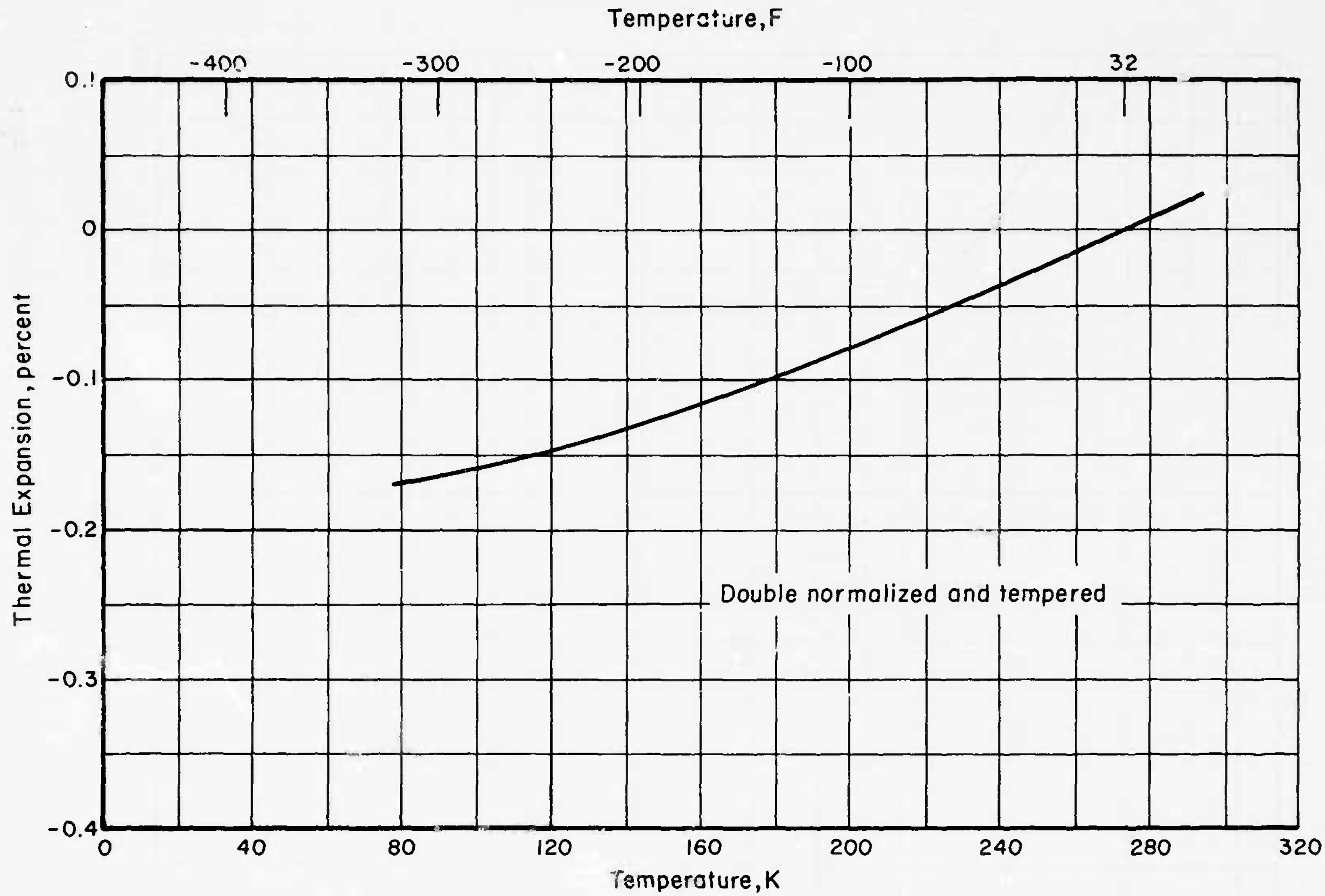

FIGURE 7.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR 9 Ni STEEL

TABLE 7.1.1-MA1

Alloy Designation: 9Ni Steel

Specification:	ASTM A353
Form:	Plate
Thickness, max; cm (in.):	5.08 (2.0)
Condition:	Double normalized and tempered

Testing Temperature, K (F)	293 (68)	273 (32)	+73 (-148)	87 (-303)
Magnetic Properties				
Susceptibility, k	0.21	0.22	0.25	0.28
Permeability*, μ	15.21×10^{-7}	15.28×10^{-7}	15.68×10^{-7}	16.08×10^{-7}
Reference: 90537				

*B_s/H; H = 16,700 Oe

TABLE 7.1.2-ME1

Alloy Designation: 18Ni (200) Maraging Steel

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed 1090 K (1500 F) 1 hr, AC, aged 756 K (900 F) 3 or 4 hr

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1486 (216)		1952 (283)	2121 (308)		
	Min	1470 (213)		1930 (280)	2050 (297)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1449 (210)		1882 (273)	2115 (307)		
	Min	1380 (200)		1855 (269)	2040 (296)		
Std. Deviation							
Elong, percent	Avg	9		8	5		
	Min	7		6	5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)		5 (2)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg	186 (27.0)		202 (29.3)			
	Min	185 (26.9)		201 (29.1)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1850 (268)		2450 (355)	2480 (359)		
K_t = 6.3	Min	1830 (265)		2310 (335)	2360 (342)		
No. of Spec. (No. of Heats)		5 (1)		9 (1)	6 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 83169, 90115

TABLE 7.1.2-ME1.1

Alloy Designation: 18Ni (200) Maraging Steel (Weld Metal)

Specification:
Form: Plate-TIG welded, 18Ni Maraging steel filler
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Plate aged 760 K (905 F) 4 hr, AC; welded, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1490 (216)			1900 (275)		
	Min	1480 (215)			1850 (269)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1440 (209)			1750 (254)		
	Min	1430 (208)			1590 (230)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			6 (1)		
E, GN/m^2 (10^6 psi)	Avg	177 (25.7)			194 (28.2)		
	Min				181 (26.2)		
No. of Spec. (No. of Heats)		1			5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90115

TABLE 7.1.2-ME2

Alloy Designation: 18Ni (200) Maraging Steel

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Solution treated and aged at 760 K (905 F) 4 hr

Testing Temperature, K (F)		297	(75)		77	(-320)			
Tension, Longitudinal									
TUS, MN/m^2 (ksi)	Avg	1569	(228)		2019	(293)			
	Min	1530	(222)		1980	(288)			
Std. Deviation									
TYS, MN/m^2 (ksi)	Avg	1516	(220)		1951	(283)			
	Min	1470	(213)		1910	(277)			
Std. Deviation									
Elong, percent	Avg	16			13				
	Min	13			12				
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		4	(2)		4	(2)			
E, GN/m^2 (10^6 psi)	Avg	185	(26.8)		195	(23.2)			
	Min	183	(26.5)		192	(27.9)			
No. of Spec. (No. of Heats)		4	(2)		4	(2)			
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m^2 (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m^2 (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m^2 (10^6 psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									

References: 90115

TABLE 7.1.2-ME2.1

Alloy Designation:	18Ni (200) Maraging Steel
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Aged at 760 K (905 F) 3 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg		2274 (329.8)				
	Min		2250 (326.4)				
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg		2214 (321.1)				
	Min		2198 (318.8)				
Std. Deviation							
Elong, percent	Avg		6.4				
	Min		6.0				
RA, percent	Avg		45.0				
	Min		40.7				
No. of Spec. (No. of Heats)			4 (1)				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90624

TABLE 7.1.2-ME3

Alloy Designation:	18Ni (200) Maraging Steel
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Annealed and aged at 760 K (905 F) 3-4 hr.

Testing Temperature, K (F)		297 (75)		77 (-320)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg			36.8 (40.2)			
	Min			28.8 (31.6)			
Orientation: –							
No. of Spec. (No. of Heats)				10 (2)			
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg			77.4 (70.8)			
(From PTSC spec.)(–)	Min			68.7 (62.9)			
No. of Spec. (No. of Heats)				6 (2)			

References: 90624

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data. Compact Tension

505

TABLE 7.1.2-ME3.1

Alloy Designation: 18Ni (200) Maraging Steel (Weld Metal)

Specification:
Form: Plate-TIG welded, 18Ni Maraging steel filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate aged 760 K (905 F) 4 hr, AC; welded, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1520 (221)			1980 (287)		
	Min	1517 (220)			1970 (286)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1410 (204)			1850 (269)		
	Min	1380 (200)					
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg	180 (26.1)			180 (26.1)		
	Min	172 (25.0)			170 (24.6)		
No. of Spec. (No. of Heats)		3 (1)					
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90115

TABLE 7.1.2-ME4

Alloy Designation: 18Ni (200) Maraging Steel

Specification:
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Annealed 1175 K (1650 F) 2 hr, AC, annealed 1060 K (1450 F) 2 hr, AC, aged 756 K (900 F) 2 hr

Testing Temperature K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1460 (212)	1610 (234)	1930 (280)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1420 (206)	1580 (230)	1870 (271)			
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	66	64	60			
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 80994

TABLE 7.1.2-ME5

Alloy Designation: 18Ni (200) Maraging Steel

Specification:
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Annealed 1175 K (1650 F) 2 hr, AC, annealed 1060 K (1450 F) 2 hr, AC, aged 756 K (900 F) 2 hr

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)			
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear[(a)]										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Trans., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness[(b)]										
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg	186	(170)	179	(164)	85.0	(78.7)			
	Min	184	(168)	173	(158)	80.3	(73.5)			
Orientation T – L										
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)			
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg									
(From PTSC spec.)(–)	Min									
No. of Spec. (No. of Heats)										

References: 80994

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data: Precracked bend specimens.

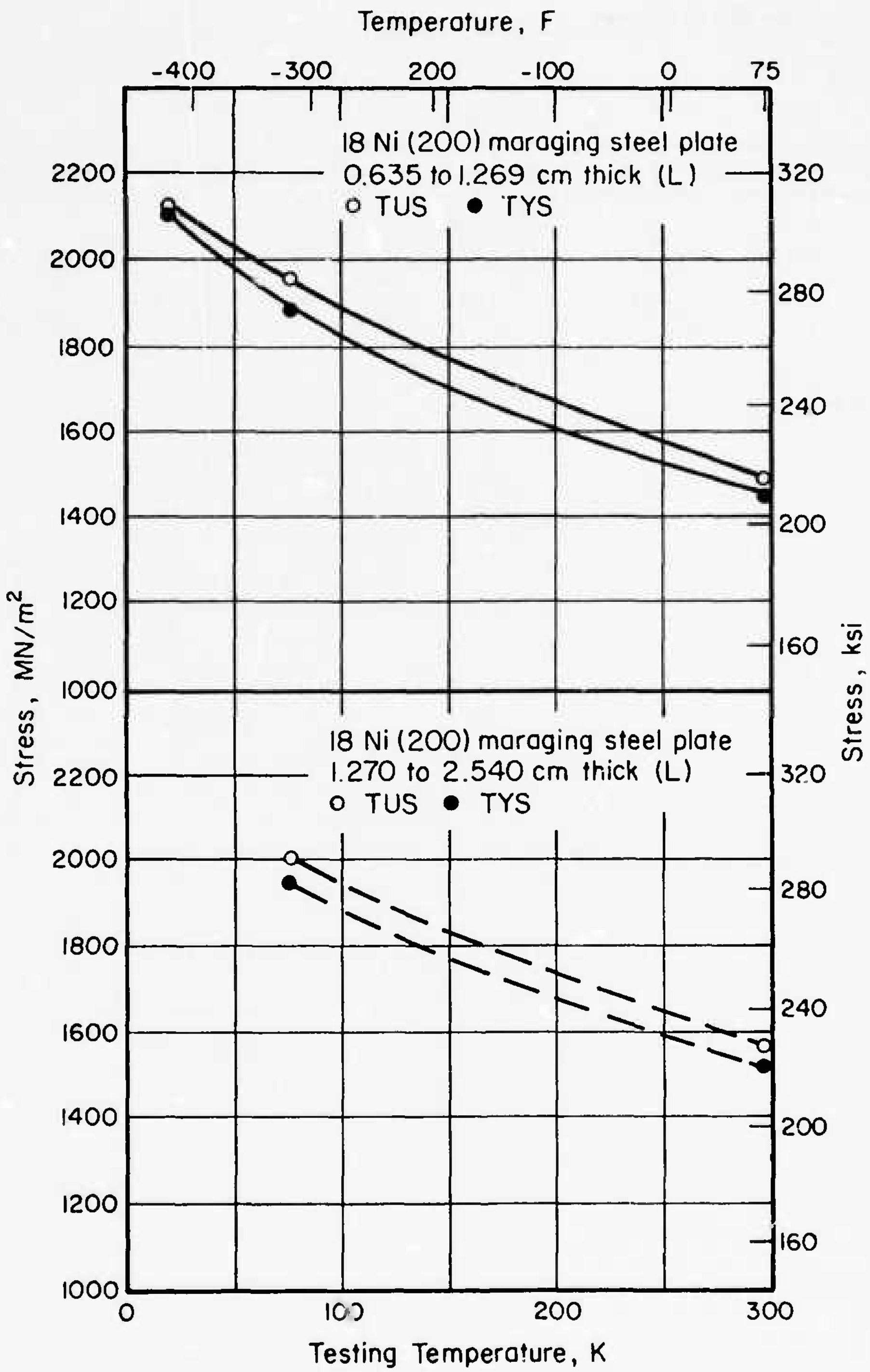

FIGURE 7.1.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 18Ni (200) MARAGING STEEL PLATE

TABLE 7.1.2-TR1

Alloy Designation: Iron Alloy 18Ni (200) Maraging Steel

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity (1)												
Watts m^{-1} K^{-1} (2)	15.2		8.1		6.7		2.0		1.0		0.37	
Btu hr^{-1} ft^{-1} F^{-1}		(8.79)		(4.7)		(3.9)		(1.2)		(0.58)		(0.21)
Watts m^{-1} K^{-1} (3)	14.2		7.7		6.5		1.9		0.92		0.34	
Btu hr^{-1} ft^{-1} F^{-1}		(8.21)		(4.4)		(3.8)		(1.1)		(0.53)		(0.20)
No. of Spec.	2		2		2		2		2		2	
References: 96888												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

(1) Material measured was Iron Alloy 18Ni (300) Maraging Steel.
(2) Perpendicular to Plate.
(3) In rolling direction.

51[illegible]

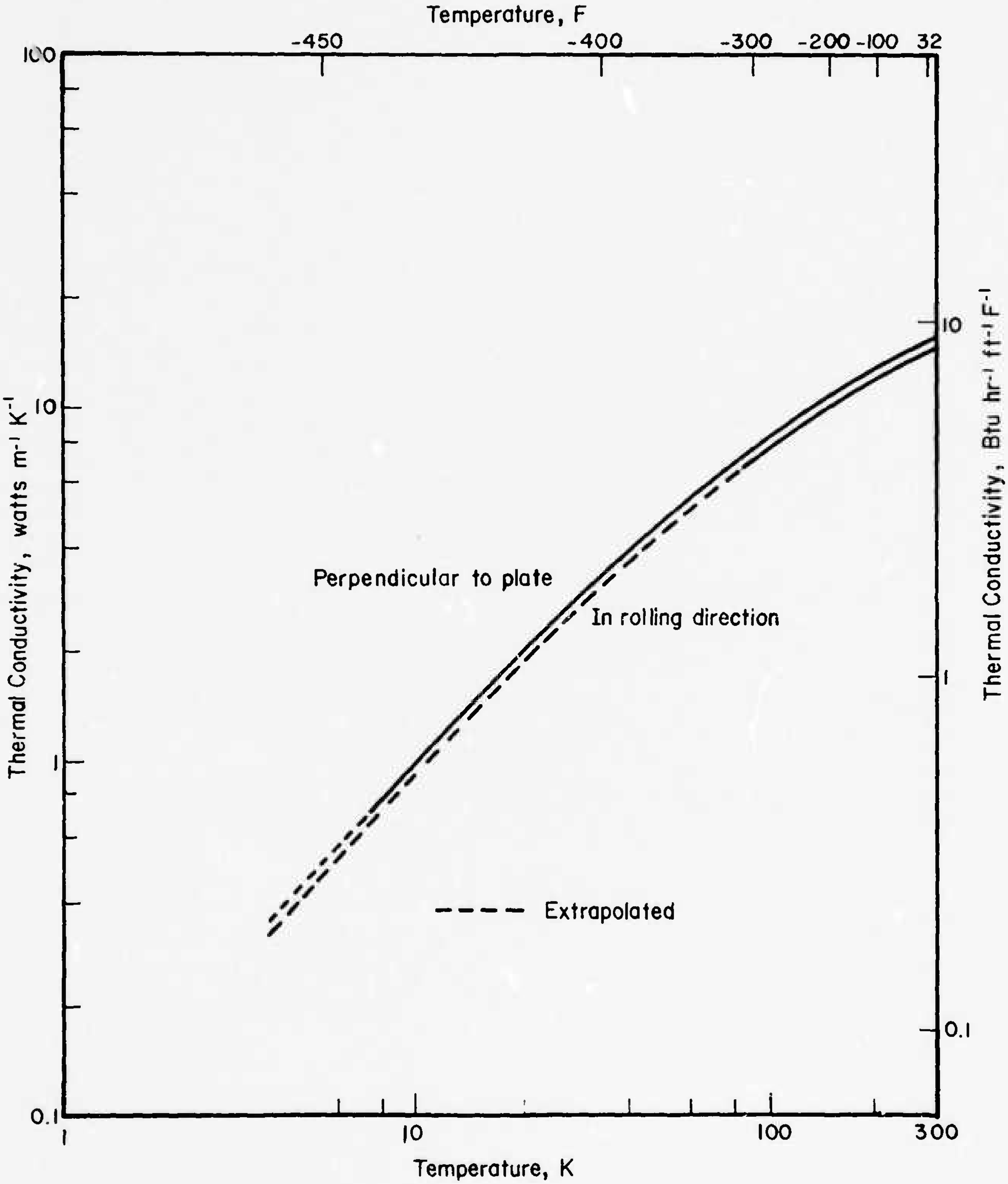

FIGURE 7.1.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY 18NI (200) MARAGING STEEL
(Material measured was Iron Alloy 18Ni (300) Maraging Steel)

TABLE 7.3.1-TR1

Alloy Designation: 1010 Steel G-10100

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	66.0											
Btu hr^{-1} ft^{-1} F^{-1}		(38.2)										
No. of Spec.	1											
References: 90224												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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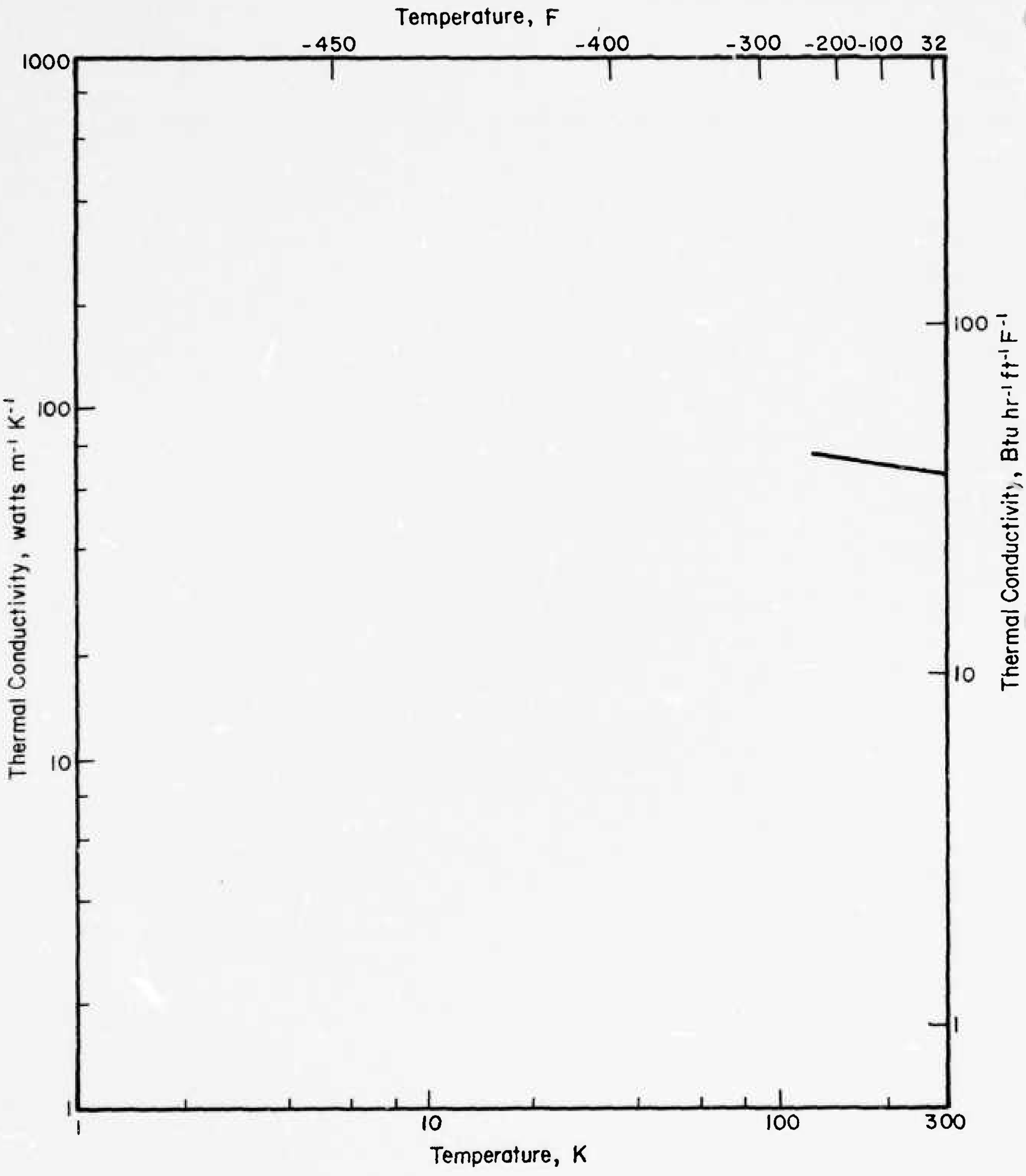

FIGURE 7.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR 1010 STEEL

TABLE 7.4.1-ME1

Alloy Designation: Armco Iron

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed and furnace cooled to 0.025 mm (10^{-5} in.) grain diam.

Testing Temperature, K (F)		297 (75)	26 (-412)	24 (-416)	17 (-429)	12 (-440)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg		879.1 (127.5)	893.6 (129.6)	809.4 (117.4)	923.2 (133.9)	935.6 (135.7)
	Min						909.4 (131.9)
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			1	1	1	1	4 (1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96682

TABLE 7.4.1-TR1

Alloy Designation: Armco Iron

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	76.1	95.4	112	67.5	34.2	
Btu hr^{-1} ft^{-1} F^{-1}	(44.0)	(55.2)	(64.8)	(39.0)	(19.8)	
No. of Spec.	3	3	3	3	3	
References: 90230						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	9.59×10^{-8}	2.08×10^{-8}	9.05×10^{-9}	7.49×10^{-9}	7.43×10^{-9}	7.43×10^{-9}
Ohm circular mil ft^{-1}	(57.7)	(12.5)	(5.44)	(4.51)	(4.47)	(4.47)
No. of Spec.	4	4	4	4	4	3
References: 90230, 96877						

51[illegible]

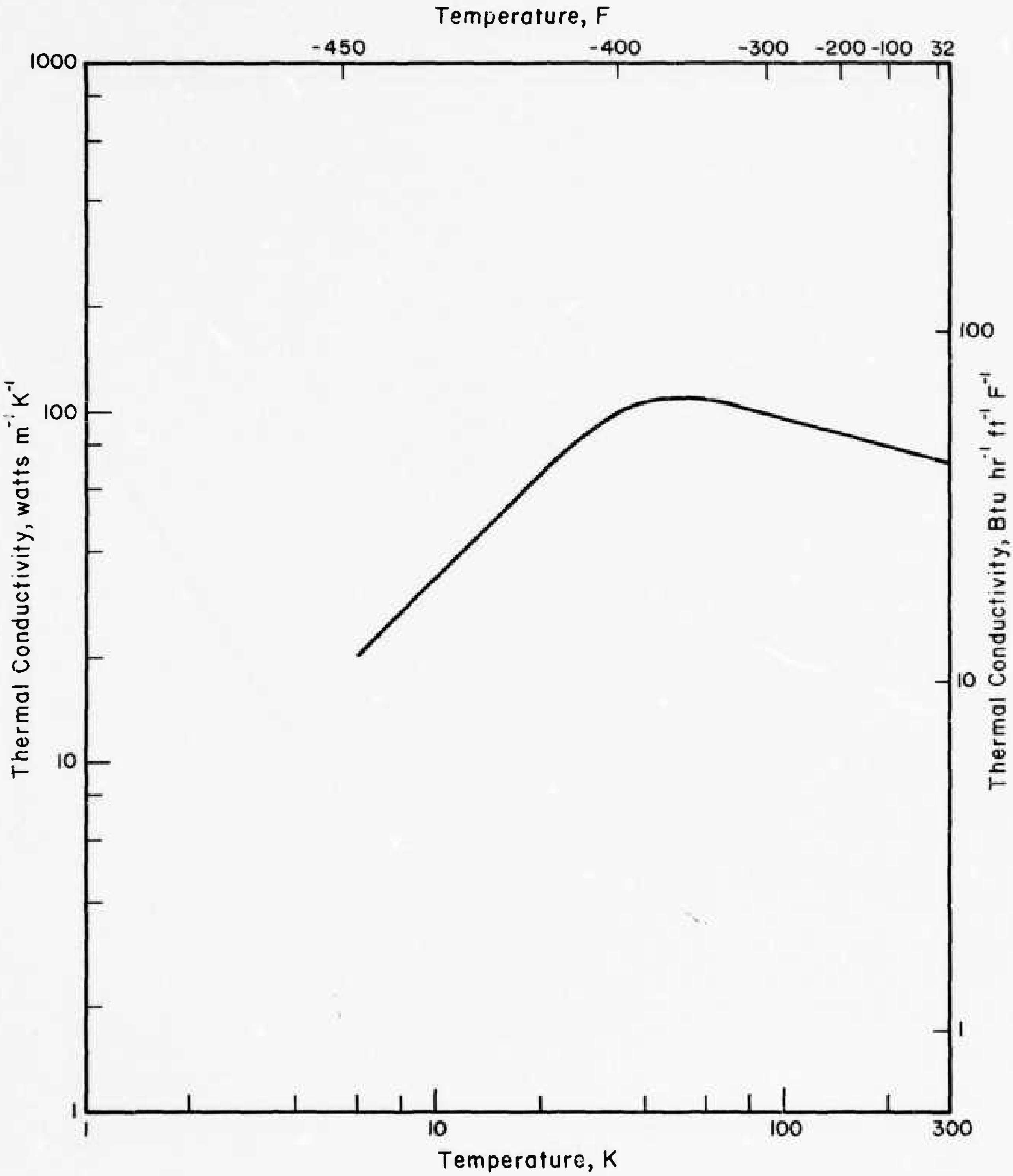

FIGURE 7.4.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ARMCO IRON

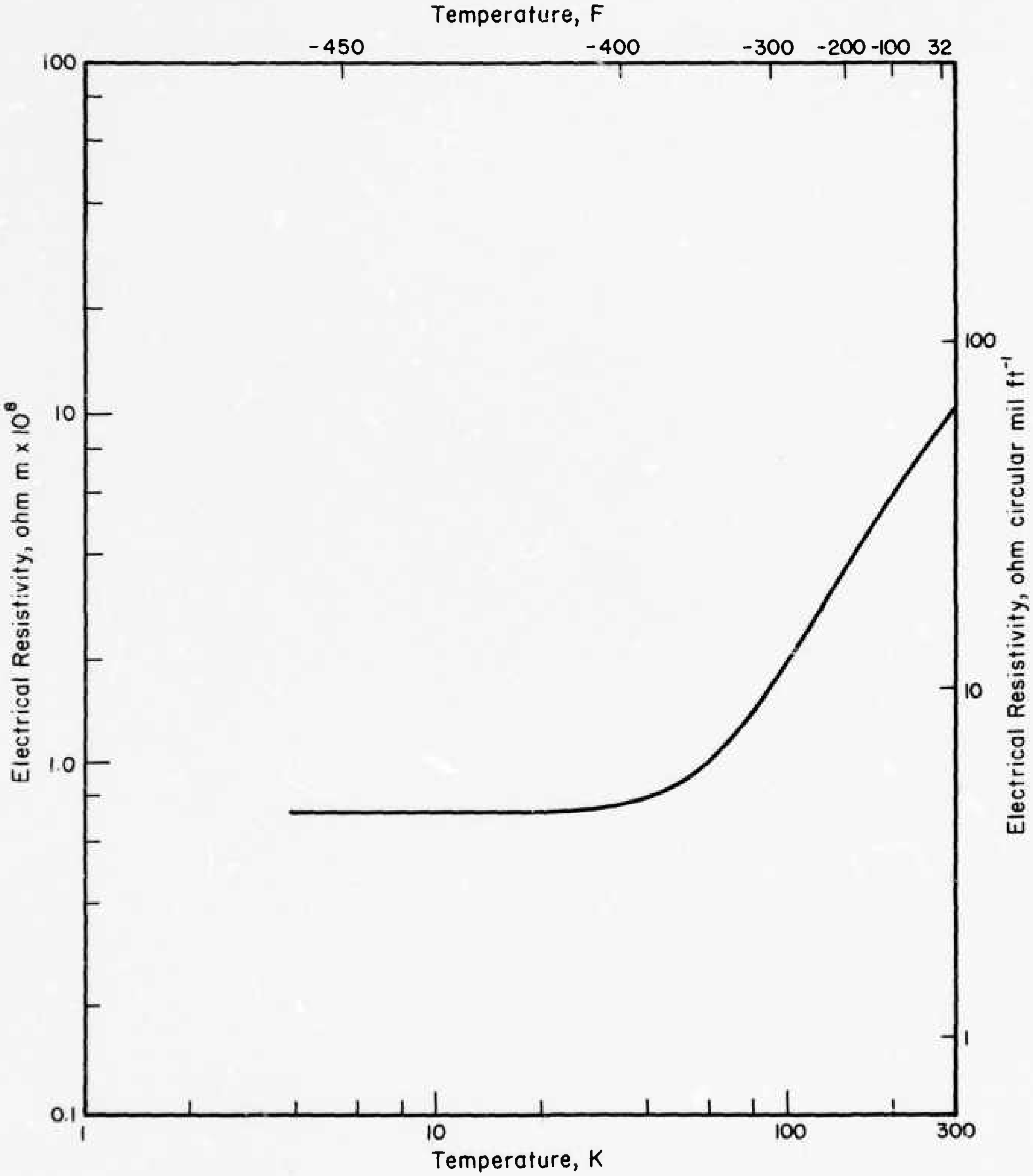

FIGURE 7.4.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ARMCO IRON

TABLE 7.4.3-ME1

Alloy Designation: 5Ni Steel

Specification: ASTM A645
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Quenched, temperized, and reversion annealed per spec.

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)				228 (33.0)		
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N/TUS at 10^7 cycles				0.21		
S_N at 10^8 cycles, MN/m^2(ksi)				200 (29)		
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N/TUS at 10^8 cycles				0.18		

References: 96687

TABLE 7.4.3-ME2

Alloy Designation: 5Ni Steel

Specification:	ASTM A645
Form:	*Plate*
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Quenched, temperized and reversion annealed per spec.

Testing Temperature, K (F)		297 (75)		105 (-270)	77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V *							
Long., Nm(ft-lb)	Avg			65.3 (49.4)	63.5 (47.0)		
	Min			58 (43)	55 (41)		
No. of Spec. (No. of Heats)				5 (1)	6 (1)		
Trans., Nm(ft-lb)	Avg			54.0 (40.0)	51.3 (38.0)		
	Min			43 (32.0)	41 (30)		
No. of Spec. (No. of Heats)				5 (1)	6 (1)		
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg			67.2 (384)	7.7 (44)		
	Min			57.1 (326)	6.1 (35)		
Orientation –							
No. of Spec. (No. of Heats)				>1	>1		
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 96684, 96687

(a) Indicate specimen design and orientation for shear specimens:
(b) *Indicate specimen design for K_{Ic} data:*
* Data are for half-size specimens; for full-size specimens, average longitudinal values are given as 81 Nm (60 ft-lb) and 112 Nm (83.0 ft-lb) for temperatures of 105 K and 77 K, respectively.

TABLE 7.4.3-ME3

Alloy Designation:	5Ni Steel
Specification:	ASTM A645
Form:	Plate-Pulsed MIG welded, Inconel 92 filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Plate Quenched, temperized, and reversion annealed per spec.; welded, and tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)				255 (37)		
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N/TUS at 10^7 cycles				0.28		
S_N at 10^8 cycles, MN/m^2(ksi)						
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N/TUS at 10^8 cycles				0.27		

References: 96687

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TABLE 7.4.3-ME4

Alloy Designation:	5Ni Steel (Weld Metal)
Specification:	ASTM A645
Form:	Plate-shielded MIG welded (Incoweld Bm covered electrode)
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	*Quenched, temperized, and reversion annealed per spec.; welded, tested as welded*

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)				255 (37)		
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N/TUS at 10^7 cycles				0.28		
S_N at 10^8 cycles, MN/m^2(ksi)				241 (35)		
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N/TUS at 10^8 cycles				0.27		

References: 96687

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TABLE 7.4.3-ME5

Alloy Designation: 5Ni Steel

Specification: ASTM A645
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Quenched, temperized, and reversion annealed per spec.

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	724 (105)			1120 (163)		
	Min	689 (100)			1110 (160)		
Std. Deviation		21.2 (3.07)					
TYS, MN/m^2 (ksi)	Avg	572 (82.9)			807 (117)		
	Min	490 (71)			745 (108)		
Std. Deviation		45.0 (6.53)					
Elong, percent	Avg	31.2			31.0		
	Min	28			29		
RA, percent	Avg	72.8					
	Min	69					
No. of Spec. (No. of Heats)		13 (2)			5 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 92996

TABLE 7.4.3-ME6

Alloy Designation: 5Ni Steel

Specification: ASTM A645
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Quenched, tempe(r)ized, and reversion annealed per spec.

Testing Temperature, K (F)	297 (75)		105 (-270)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m^2 (ksi) Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m^2 (10^6 psi) Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb) Avg			130 (98)	119 (88.5)		
Min				105 (78)		
No. of Spec. (No. of Heats)			1	6 (1)		
Trans., Nm(ft-lb) Avg			110 (84)	61.7 (45.7)		
Min			100 (76)	38 (28)		
No. of Spec. (No. of Heats)			2 (1)	6 (1)		
Fracture Toughness(b)						
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$) Avg						
Min						
Orientation –						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$) Avg						
(From PTSC spec.)(–)Min						
No. of Spec. (No. of Heats)						

References: 96686, 96687

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 7.4.3-ME7

Alloy Designation: 5Ni Steel

Specification: ASTM A645
Form: Plate-Pulse MIG welded, Inconel 92(1) filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Quenched, temperized, and reversion annealed per spec.; welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg		799.1 (115.9)	855.0 (124.0)	979.1 (142.0)		
	Min		797.7 (115.7)	850.8 (123.4)	978.4 (141.9)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			2 (1)	2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96687

TABLE 7.4.3-ME8

Alloy Designation: 5Ni Steel

Specification: ASTM A645
Form: Plate
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)		297 (75)	195 (-108)	110 (-270)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	708.8 (102.8)	843.9 (122.4)	930.8 (135.0)	1137 (164.9)		
	Min	687 (99.6)			1136 (164.8)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	487 (70.6)	434 (63.0)	572 (82.9)	726.0 (105.3)		
	Min	468 (67.9)		521 (75.6)	719.8 (104.4)		
Std. Deviation							
Elong, percent	Avg	32.0	30	28	29.5		
	Min	29			29		
RA, percent	Avg	70.7	70	68	62		
	Min	69					
No. of Spec. (No. of Heats)		4 (3)	1	2 (2)	3 (3)		
E, GN/m² (10⁶ psi)	Avg	198 (28.7)			212 (30.7)		
	Min						
No. of Spec. (No. of Heats)		1			1		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 92996, 96684, 96687

TABLE 7.4.3-ME9

Alloy Designation:	5Ni Steel
Specification:	ASTM A645
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	Quenched, temperized, and reversion annealed per spec.

Testing Temperature, K (F)		297 (75)		195	(-108)	110	(-270)	77	(-320)			4	(-452)
Compression, Longitudinal													
CYS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Ec, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Compression, Transverse													
CYS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Ec, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Shear[a]													
SUS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
G, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Impact, Charpy V													
Long., Nm(ft-lb)	Avg						(85.7)		(58.7)				
	Min						(84)		(57)				
No. of Spec. (No. of Heats)						3	(1)	3	(1)				
Trans., Nm(ft-lb)	Avg						(89.7)		(40.0)				
	Min						(82)		(36)				
No. of Spec. (No. of Heats)						3	(1)	3	(1)				
Fracture Toughness[b]													
J_{Ic} KJ/m^2 (in.-lb/in.^{2})	Avg		(1270)		(925)		(971)		(176)				(865)
	Min				(400)		(774)		(91)				(710)
Orientation: –													
No. of Spec. (No. of Heats)		4	(1)	4	(2)	3	(1)	4	(2)			2	(1)
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg												
(From PTSC spec.)(–)	Min												
No. of Spec. (No. of Heats)													

References: 96684, 96699

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 7.4.3-ME10

Alloy Designation: 5Ni Steel (Weld Metal)

Specification: ASTM A645
Form: Plate-Pulse MIG welded, Inconel 92 filler
Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
Condition: Quenched, temperized, and reversion annealed per spec.; welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg		788.1 (114.3)	906.7 (131.5)	1010 (146.5)		
	Min			880.0 (128.8)	994.9 (144.3)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			1	2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 96687

TABLE 7.4.3-ME11

Alloy Designation: 5Ni Steel

Specification:	ASTM A645
Form:	Plate-Submerged arc welded, Inco 82 electrode, Incoflux 4
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	Quenched, temperized, and reversion annealed; welded, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg				85.6 (63.4)		
	Min				50 (37)		
No. of Spec. (No. of Heats)					8 (1)		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 96686

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

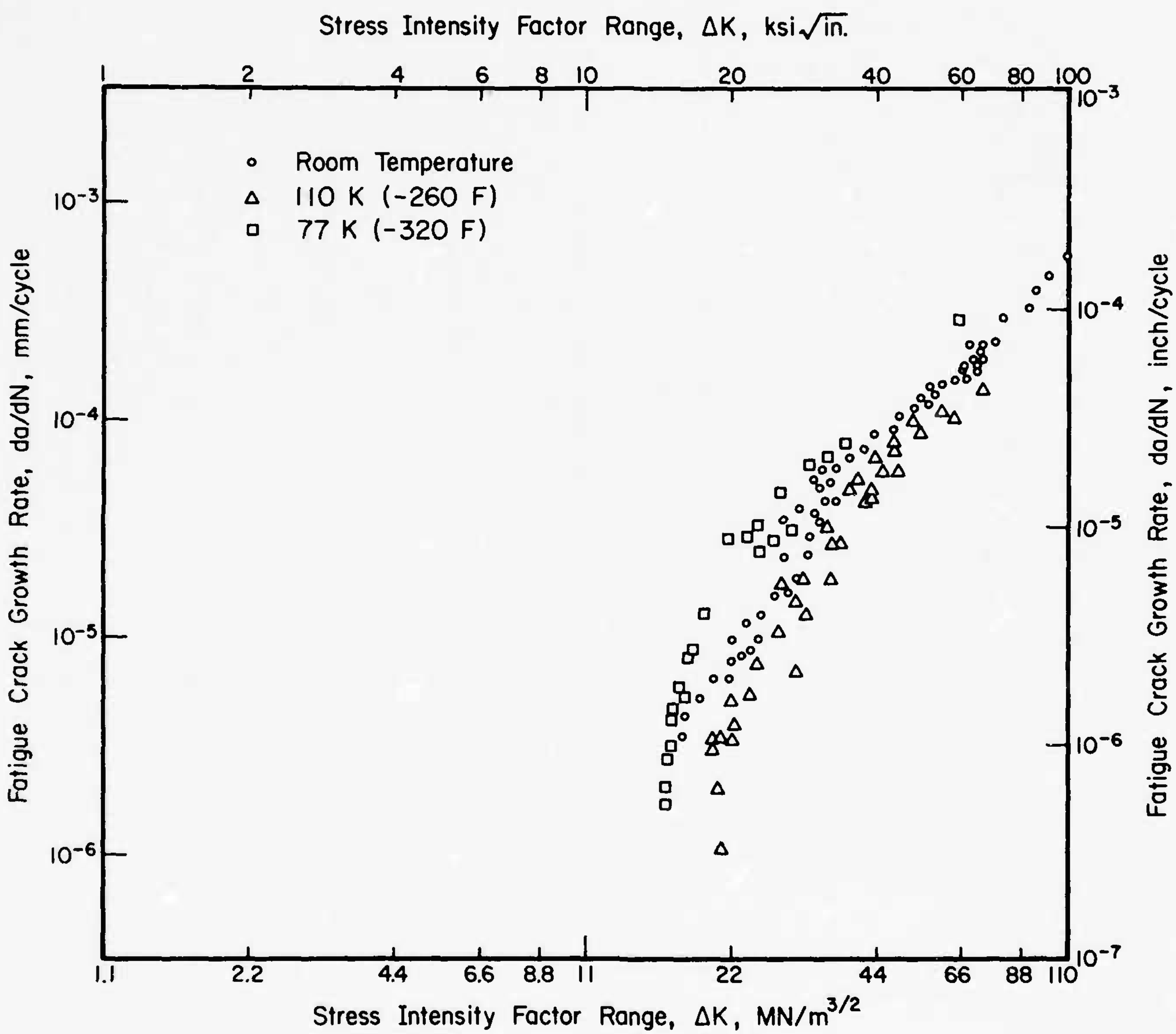

FIGURE 7.4.3-ME1. FATIGUE CRACK GROWTH RATE CURVES FOR 5NI STEEL (ASTM A645) PLATE AT ROOM TEMPERATURE, 110 K, and 77 K [96686]
Heat Treatment: Quenched, temperized, and reversion annealed per spec.

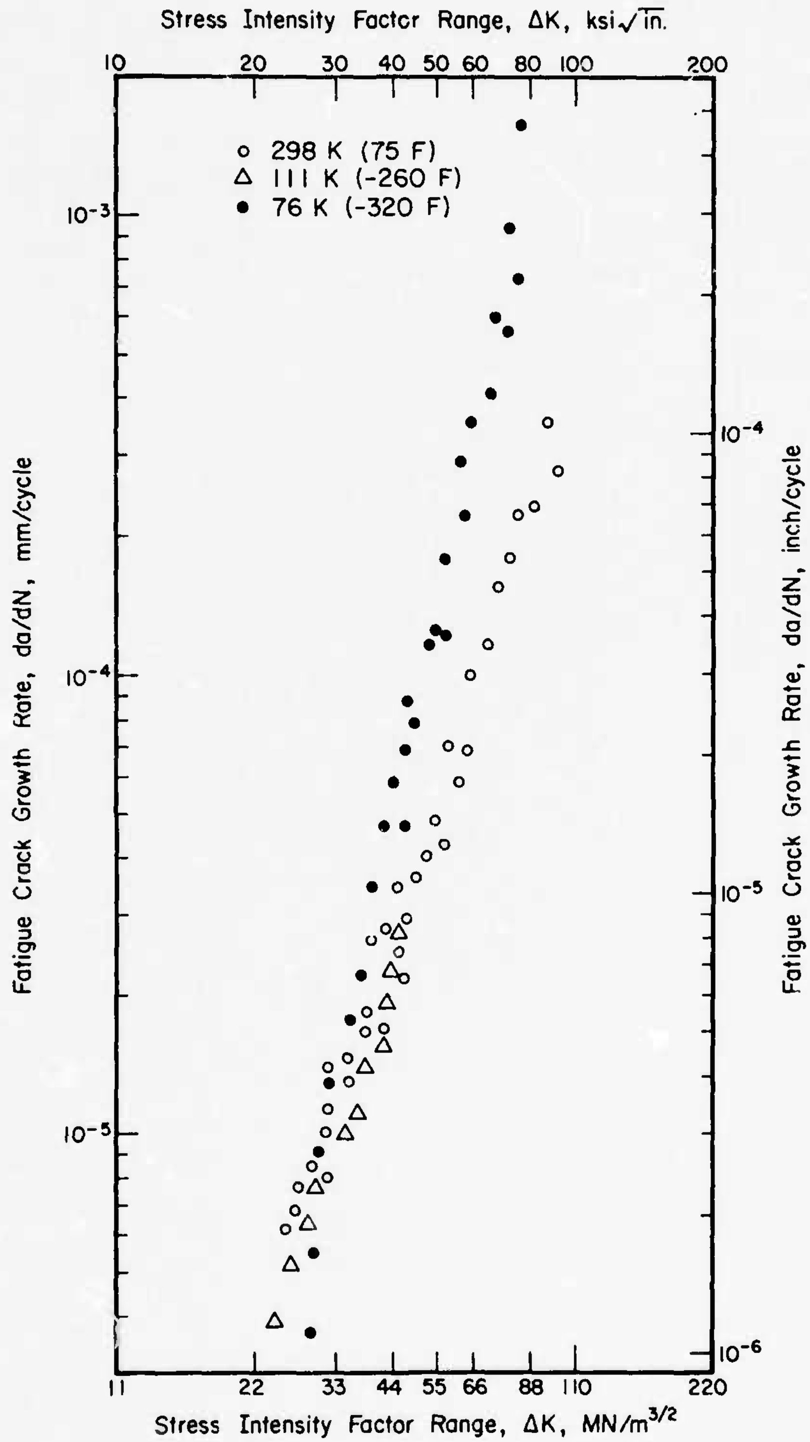

FIGURE 7.4.3-ME2. FATIGUE CRACK GROWTH RATE CURVES FOR 5NI STEEL (ASTM A645) PLATE AT ROOM TEMPERATURE, 110 K, and 77 K[96699]

TABLE 7.4.3-TR1

Alloy Designation: Iron Alloy Fe-5Ni

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	37.5		22.0		13.0		5.70		2.80		1.00	
Btu hr^{-1} ft^{-1} F^{-1}		(21.7)		(12.7)		(7.52)		(3.30)		(1.62)		(0.578)
No. of Spec.	2		2		2		2		2		2	
References: 90170												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

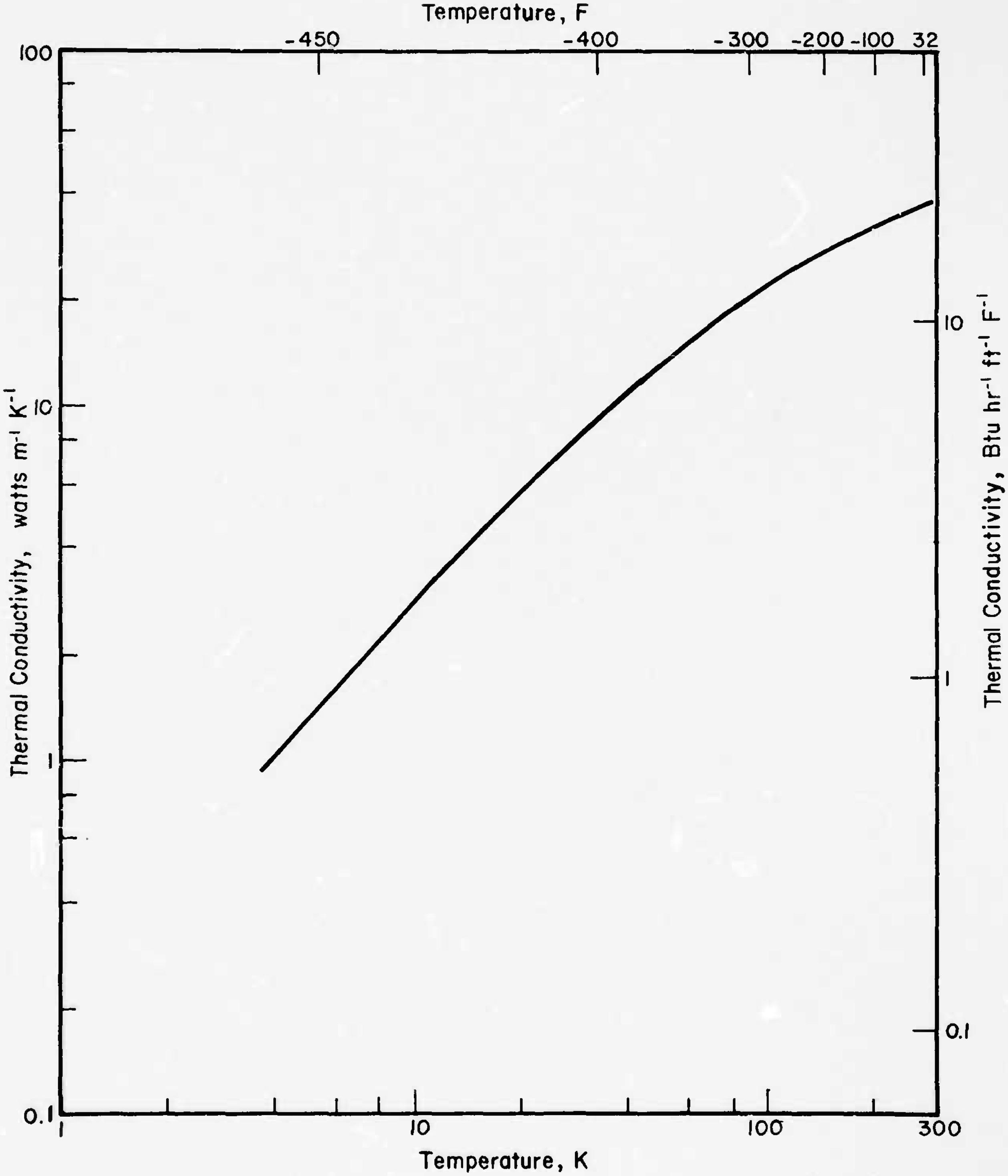

FIGURE 7.4.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY Fe-5Ni

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TABLE 7.4.4-TR1

Alloy Designation: Fe(47-50)Ni Alloy

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	H, tesla	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity													
Watts m^{-1} K^{-1} (1)		20.0		13.9		8.70		4.00		2.00		0.72	
Btu hr^{-1} ft^{-1} F^{-1}			(11.6)		(8.04)		(5.03)		(2.31)		(1.16)		(0.42)
Watts m^{-1} K^{-1} (2)		16.7		11.3		7.10		3.35		1.70		0.61	
Btu hr^{-1} ft^{-1} F^{-1}			(9.66)		(6.53)		(4.11)		(1.94)		(0.98)		(0.35)
No. of Spec.		2		2		2		2		2			
References: 96888													
Thermal Expansion (T_{273} to T) Longitudinal													
Percent		0		-0.151		-0.172		-0.175		-0.175		-0.175	
No. of Spec.		1		1		1		1		1		1	
References: 74405													
Specific Heat													
Joules kg^{-1} K^{-1}													
Btu lb^{-1} F^{-1}													
No. of Spec.													
References:													
Electrical Resistivity													
Ohm m		39.2×10^{-8}		21.0×10^{-8}		18.4×10^{-8}		17.6×10^{-8}		17.5×10^{-8}		17.4×10^{-8}	
Ohm circular mil ft^{-1}			(236)		(126)		(111)		(106)		(105)		(105)
No. of Spec.		1		1		1		1		1		1	
References: 79561													
Magnetothermal Conductivity	H, tesla												
W Watts m^{-1} K^{-1}	0							3.60		2.00		0.76	
Btu hr^{-1} ft^{-1} F^{-1}									(2.08)		(1.16)		(0.44)
Watts m^{-1} K^{-1}	2							3.50		1.92		0.73	
Btu hr^{-1} ft^{-1} F^{-1}									(2.02)		(1.11)		(0.42)
Watts m^{-1} K^{-1}	4							3.50		1.92		0.73	
Btu hr^{-1} ft^{-1} F^{-1}									(2.02)		(1.11)		(0.42)
Watts m^{-1} K^{-1}	8									1.92		0.73	
Btu hr^{-1} ft^{-1} F^{-1}									(2.02)		(1.11)		(0.42)
No. of Spec.								1		1		1	
References: 96888													

(1) High Perm 49Fe-97.5Ni (perpendicular to plate)
(2) High Perm 49Fe-47.5Ni (in rolling direction)

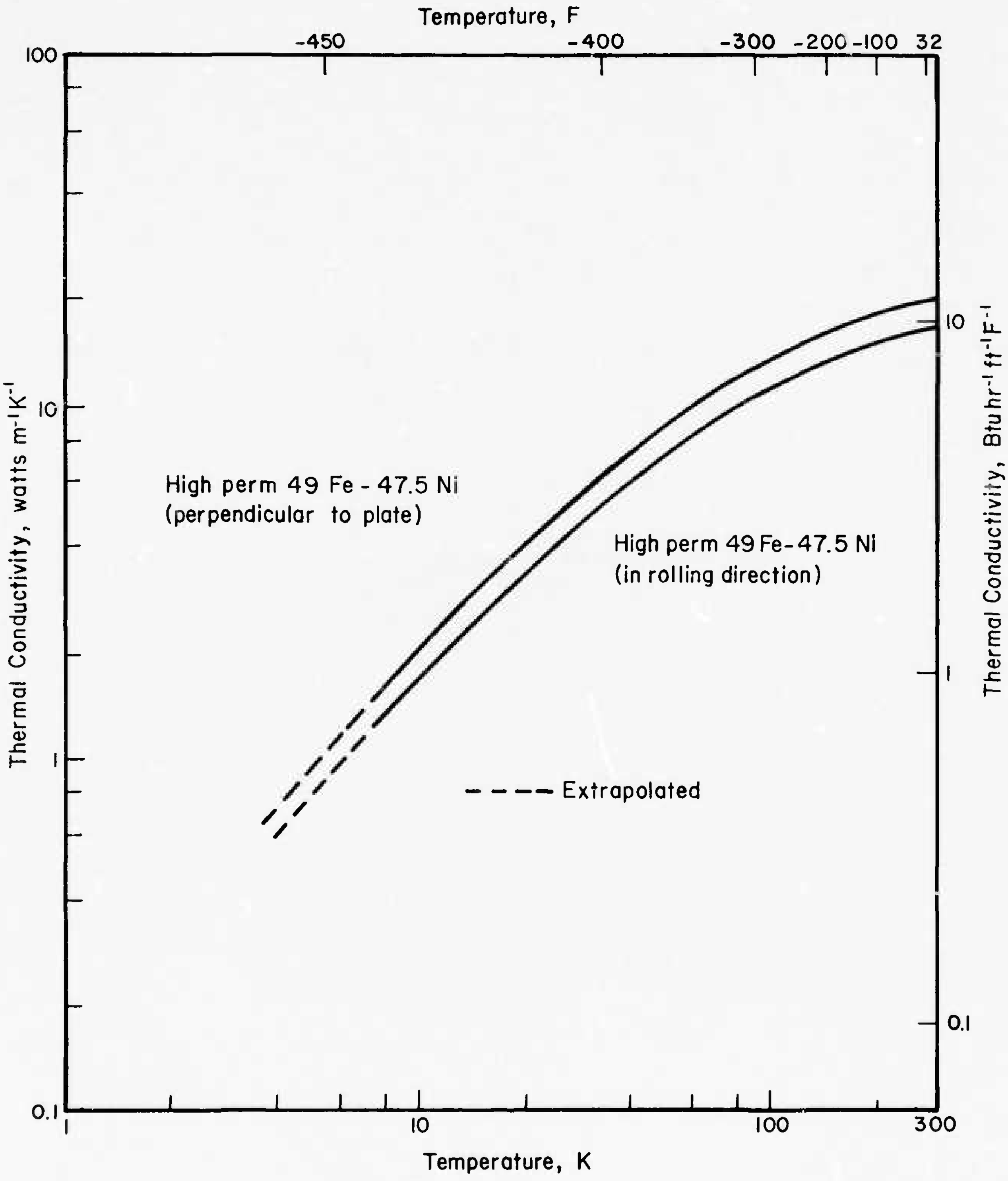

FIGURE 7.4.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY Fe(47-50)Ni

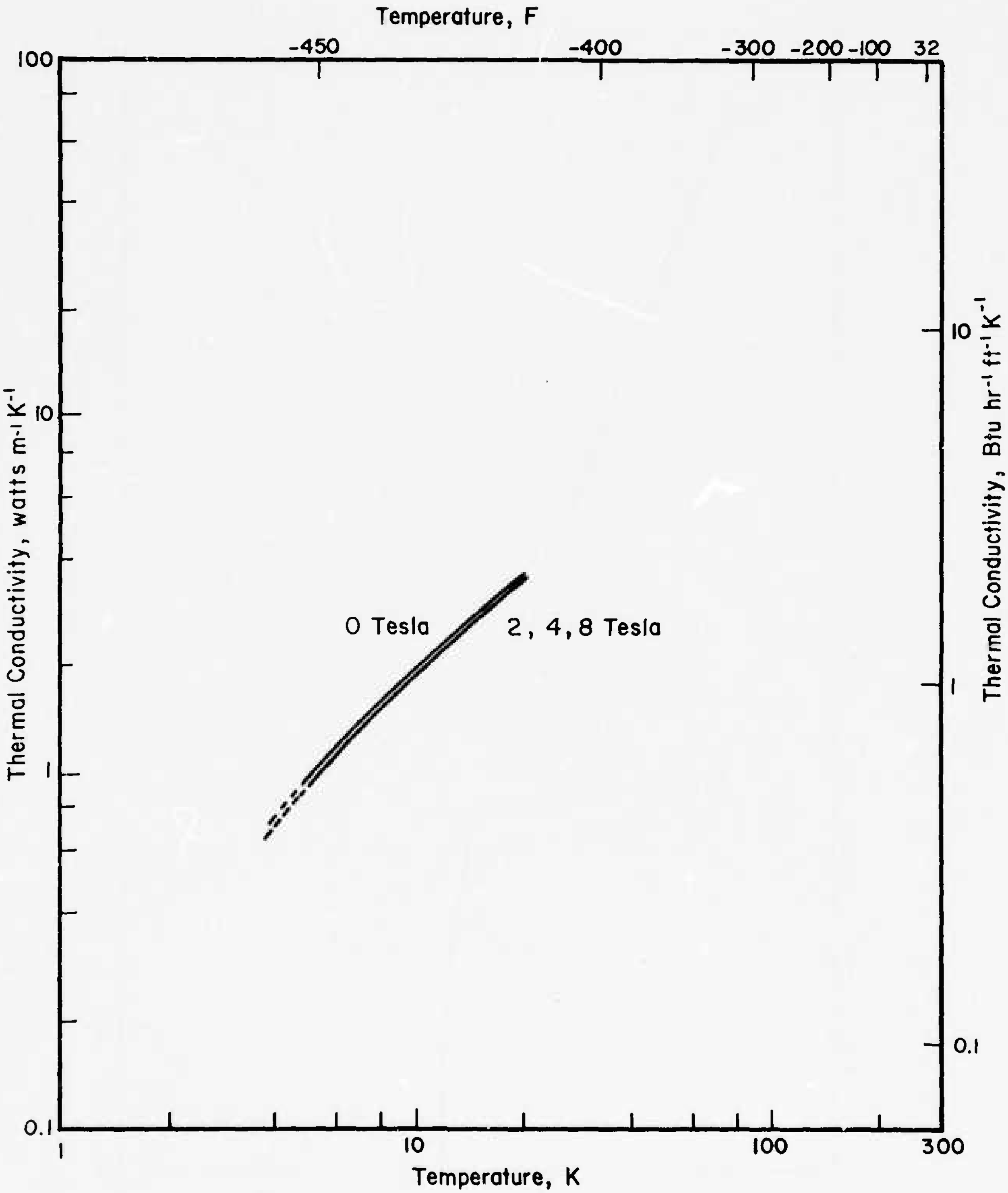

FIGURE 7.4.4-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY Fe(47-50)Ni AT SEVERAL MAGNETIC FIELDS

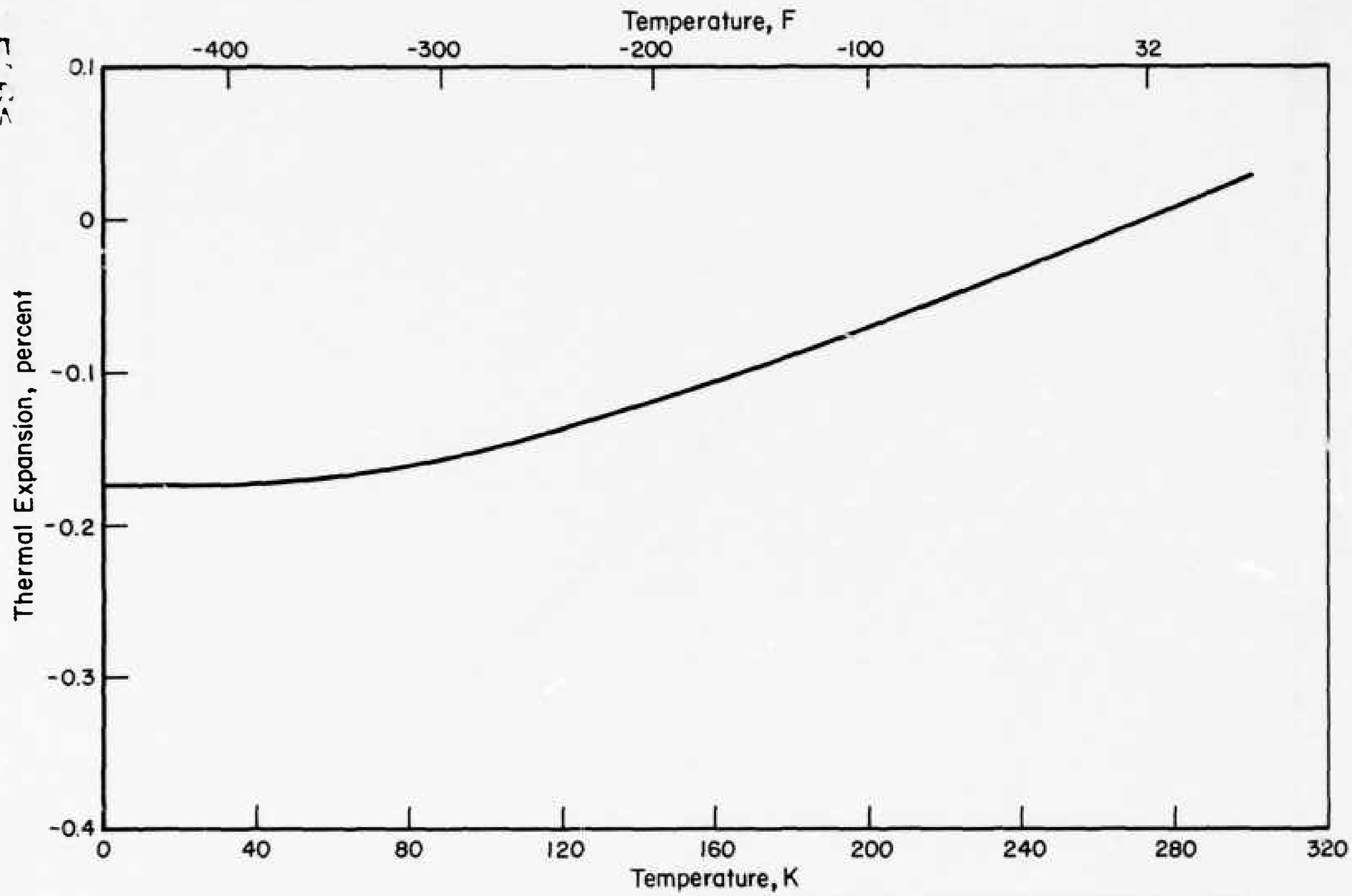

FIGURE 7.4.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR IRON ALLOY Fe(47-50)Ni

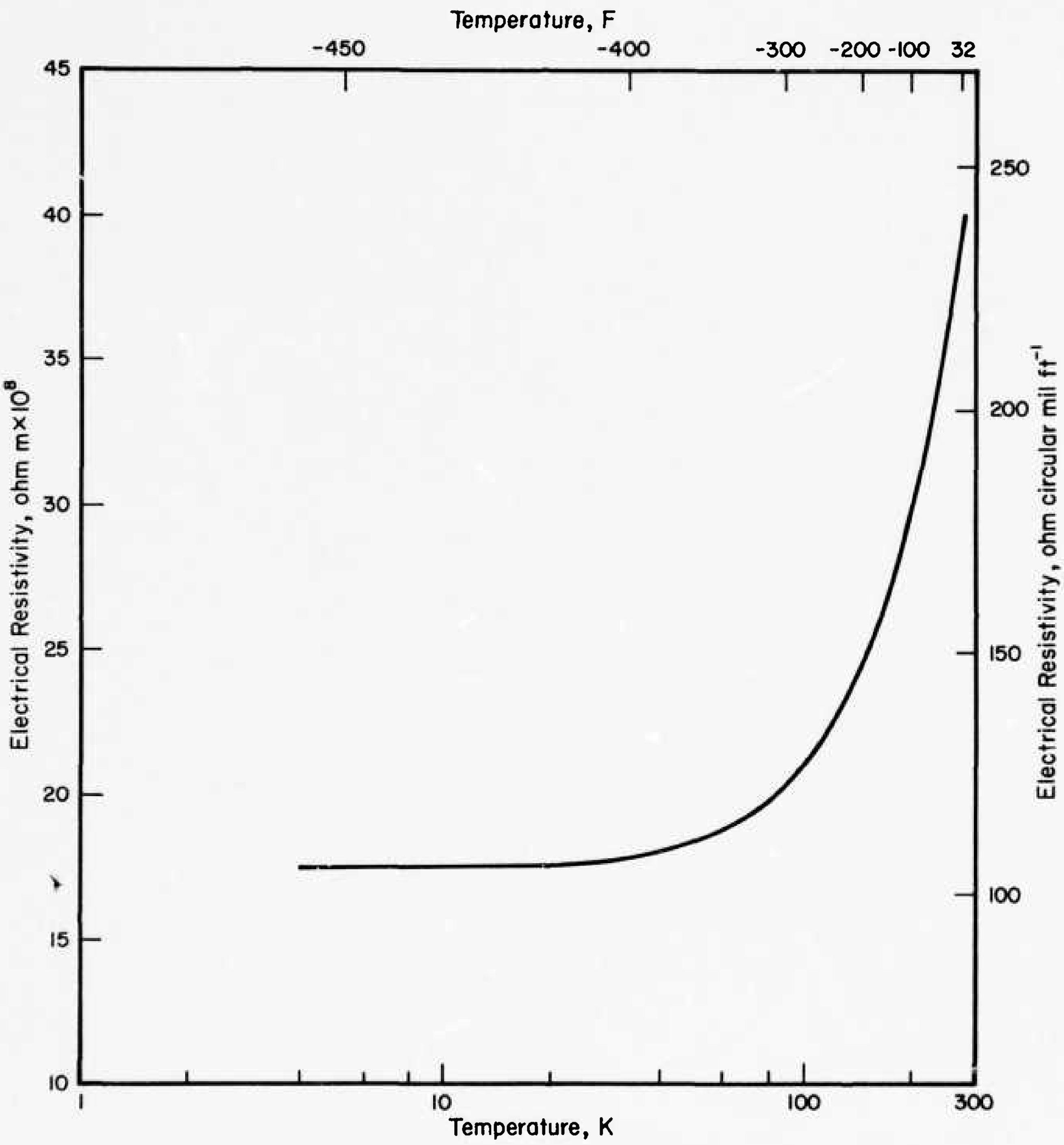

FIGURE 7.4.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR IRON ALLOY (47-50)Ni

INDEX TO MATERIAL CODES FOR
SECTION 8.0

STAINLESS STEELS

MATERIALS	MATERIAL CODE
TYPE 301	8.1.1
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TABLE 8.1.1-ME3

Alloy Designation: Type 301 Stainless Steel S30100

Specification: MIL-S-5059
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Extra hard (XH) cold rolled (60 percent or more reduction)

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)
Tension, Longitudinal									
TUS, MN/m^2 (ksi)	Avg	1558	(226)	1735	(252)	2241	(325)	2234	(324)
	Min	1393	(202)	1662	(241)	2041	(296)	1937	(281)
Std. Deviation		123.3	(17.88)	64.3	(9.33)	91.7	(13.30)	143.7	(20.85)
TYS, MN/m^2 (ksi)	Avg	1455	(211)	1543	(224)	1765	(256)	1951	(283)
	Min	1241	(180)	1427	(207)	1462	(212)	1393	(202)
Std. Deviation		131.5	(19.08)	90.9	(13.2)	177.7	(25.77)	240.9	(34.94)
Elong, percent	Avg	6.6		17.3		20.1		8.4	
	Min	1.0		14		16		0.5	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		64	(14)	11	(3)	45	(11)	74	(15)
E, GN/m^2 (10^6 psi)	Avg	180	(26.15)	190	(27.5)	189.6	(28.5)	202	(29.29)
	Min	168	(24.4)	180	(26.1)	177.8	(25.8)	179.3	(26.0)
No. of Spec. (No. of Heats)		23	(4)	5	(1)	23	(4)	29	(4)
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg	1602	(232)	1720	(250)	2034	(295)	1078	(301)
K_t = 6.3	Min	1427	(207)	1710	(248)	1868	(271)	1882	(273)
No. of Spec. (No. of Heats)		32	(8)	7	(2)	22	(6)	27	(8)
NTS, MN/m^2 (ksi)	Avg	1404	(203.7)	1430	(207)	1503	(218)	1342	(194.7)
K_t = 19+	Min	1034	(150)	1269	(184)	1255	(182)	931	(135)
No. of Spec. (No. of Heats)		23	(5)	5	(1)	26	(3)	23	(3)
Tension, Transverse									
TUS, MN/m^2 (ksi)	Avg	1673	(242.71)	1835	(266)	2269.7	(329.2)	2299	(333.46)
	Min	1496	(217)	1827	(265)	2130.5	(309)	2048	(297)
Std. Deviation		153.5	(22.27)	10.8	(1.57)	80.8	(11.72)	100.6	(14.59)
TYS, MN/m^2 (ksi)	Avg	1383	(200.58)	1318	(191)	1700	(246.63)	2003	(290.56)
	Min	1165	(169)	1207	(175)	1510	(219)	1560	(232)
Std. Deviation		191	(27.69)	70.3	(10.2)	169.7	(24.62)	172.6	(250.4)
Elong, percent	Avg	7.0		11.9		16.2		6.0	
	Min	5.0		11.0		12.0		1.0	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		38	(10)	7	(2)	27	(6)	39	(9)
E, GN/m^2 (10^6 psi)	Avg	205.6	(29.82)	204	(29.5)	217	(31.52)	224	(32.48)
	Min	180.6	(26.2)	193	(28.0)	190	(27.6)	196	(28.4)
No. of Spec. (No. of Heats)		17	(2)	5	(1)	17	(2)	17	(2)
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg	1492	(216)	1541	(224)	1728	(251)	1549	(225)
K_t = 6.3	Min	1324	(192)	1420	(206)	1462	(212)	1393	(202)
No. of Spec. (No. of Heats)		17	(6)	8	(2)	16	(5)	16	(4)
NTS, MN/m^2 (ksi)	Avg	1067	(154.75)	1001	(145)	948	(137.5)	896	(130)
K_t = 19+	Min	744.6	(108)	924	(134)	758.4	(110)	669	(97)
No. of Spec. (No. of Heats)		20	(2)	5	(1)	20	(2)	20	(2)

References: 39077, 40953, 48652, 49088, 54986, 57635, 59767, 59901, 61918, 70906, 73890

TABLE 8.1.1-ME4

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Extra hard (XH) cold rolled (60 percent or more reduction)

Testing Temperature, K (F)	297	(75)	195	(-108)	77	(-320)	20	(-423)		
Fatigue, Flexural Loading										
S_N at 10^5 cycles, MN/m^2(ksi)	717	(104)	724	(105)	945	(137)	738	(107)		
Loading frequency Hz										
with R = -1 and K_t = 1										
No. of S-N Curves (No. of Heats)	1	(1)	1	(1)	1	(1)	1	(1)		
Ratio S_N/TUS at 10^5 cycles	0.47		0.42		0.43		0.33			
S_N at 10^6 cycles, MN/m^2(ksi)	496	(72)	448	(65)	793	(115)	669	(97)		
Loading frequency Hz										
with R = -1 and K_t = 1										
No. of S-N Curves (No. of Heats)	1	(1)	1	(1)	1	(1)	1	(1)		
Ratio S_N/TUS at 10^6 cycles	0.33		0.26		0.36		0.30			
S_N at 10^7 cycles, MN/m^2(ksi)										
Loading frequency Hz										
with R = and K_t =										
No. of S-N Curves (No. of Heats)										
Ratio S_N/TUS at 10^7 cycles										
Fatigue, Flexural Loading, Notched Specimens										
S_N at 10^5 cycles, MN/m^2(ksi)	386	(56)	469	(68)	455	(66)	345	(50)		
Loading frequency Hz										
with R = -1 and K_t = 3.1										
No. of S-N Curves (No. of Heats)	1	(1)	1	(1)	1	(1)	1	(1)		
S_N at 10^6 cycles, MN/m^2(ksi)	172	(25)	214	(31)	303	(44)				
Loading frequency Hz										
with R = -1 and K_t = 3.1										
No. of S-N Curves (No. of Heats)	1	(1)	1	(1)	1	(1)	1	(1)		
S_N at 10^7 cycles, MN/m^2(ksi)										
Loading frequency Hz										
with R = and K_t =										
No. of S-N Curves (No. of Heats)										
Ratio S_N/TUS at 10^7 cycles										

References: 49048

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TABLE 8.1.1-ME4.1

Alloy Designation: Type 301 Stainless Steel (Weld Metal) S30100

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Sheet 40% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	924 (134)	1470 (214)		1940 (281)	1770 (236)	
	Min	917 (133)	1450 (211)		1890 (274)	1720 (250)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	21	18		14	3	
	Min	20	17		14	0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	5 (1)		4 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.1-ME4.2

Alloy Designation:	Type 301 Stainless Steel (Weld Metal) S30100
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	60% cold rolled sheet, welded and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1104 (160.1)	1489 (215.9)		2009 (291.4)	1536 (222.8)	
	Min	1007 (146)	1427 (207)		1944 (282)	1220 (177)	
Std Deviation		81.4 (11.8)	46.4 (6.73)		46.7 (6.77)	161 (23.3)	
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	3.9	7.2		13.8	2.7	
	Min	2.5	5.0		10.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (5)	11 (3)		15 (5)	16 (5)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1121 (162.6)	1489 (215.9)		1980 (287.2)	1461 (211.9)	
	Min	1035 (150)	1448 (210)		1944 (282)	1179 (171)	
Std. Deviation		82.7 (12.0)			27.7 (4.02)	190 (27.6)	
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	2.9	3.6		7.6	1.6	
	Min	2.0	2.0		4.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (4)	7 (2)		10 (4)	10 (4)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39429, 48652

TABLE 8.1.1-ME4.3

Alloy Designation: Type 301 Stainless Steel (Weld Metal) S30100

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Sheet 80% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	917 (133)			1940 (281)	1960 (284)	
	Min	889 (129)			1920 (278)	1840 (267)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	10			4	5	
	Min	6			2	5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			4 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.1-ME4.4

Alloy Designation: Type 301 Stainless Steel S30100

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Cryostretched to 932 MN/m² (135 ksi) at 77 K (-320 F); simulated resin cure cycled 340 K (150 F) 3 hr. + 420 K (300 F) 5 hr.

Testing Temperature, K (F)		297 (75) [(a)]			77 (-320)		
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	1409 (204.3)			1955 (283.5)		
	Min	1372 (199.0)			1931 (280.0)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1199 (173.9)			1351 (195.9)		
	Min	1165 (169.0)			1310 (190.0)		
Std. Deviation							
Elong, percent	Avg	13.6			23.4		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			2 (1)		
E, GN/m² (10⁶ psi)	Avg	144 (20.9)			168 (24.4)		
	Min	132 (19.1)			138 (20.0)		
No. of Spec. (No. of Heats)		3 (1)			12 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 87612

(a) Specimens subjected to simulated sizing load to 1442 MN/m² (209.2 ksi) at 77 K (-320 F) prior to room temperature tests.

TABLE 8.1.1-ME7

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059C
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Extra hard (XH) cold rolled

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	1431	(208)	1678	(243)	2210	(320)	2212	(321)	2140	(310)
	Min	1351	(196)	1655	(240)	2041	(296)	2151	(312)	2103	(305)
Std. Deviation		59.9	(8.69)	16.7	(2.43)	73.1	(10.6)	42.7	(6.20)		
TYS, MN/m^2 (ksi)	Avg	1267	(184)	1258	(182)	1459	(212)	1658	(240)	1934	(280)
	Min	1138	(165)	1207	(175)	1207	(175)	1489	(216)	1882	(273)
Std. Deviation		75.8	(11.0)	51.7	(7.50)	147	(21.3)	132	(19.1)		
Elong, percent	Avg	11.8		27.3		23		16.8		2.3	
	Min	4		26		16		15		2	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		20	(7)	13	(5)	18	(7)	14	(5)	3	(1)
E, GN/m^2 (10^6 psi)	Avg	172	(25.0)	172	(25.0)	166	(24.1)	178	(25.8)		
	Min	171	(24.8)	167	(24.3)	165	(23.9)	162	(23.5)		
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1604	(233)	1641	(238)	1857	(269)	1700	(246)		
K_t = 6.3	Min	1510	(219)	1572	(228)	1793	(260)	1413	(205)		
No. of Spec. (No. of Heats)		11	(4)	9	(4)	9	(4)	8	(3)		
NTS, MN/m^2 (ksi)	Avg	1517	(220)			1627	(236)	1606	(233)		
K_t = 19+	Min										
No. of Spec. (No. of Heats)		3	(1)			3	(1)	3	(1)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	1505	(218)	1713	(248)	2125	(308)	2053	(298)		
	Min	1476	(214)	1689	(245)	1841	(267)	1717	(249)		
Std. Deviation		29.0	(4.21)	20.8	(3.02)	146	(21.2)	166	(24.1)		
TYS, MN/m^2 (ksi)	Avg	1189	(172)	1178	(171)	1416	(205)	1666	(242)		
	Min	1158	(168)	1165	(169)	1255	(182)	1489	(216)		
Std. Deviation		28.1	(4.07)	9.4	(1.36)	153	(22.2)	145	(21.0)		
Elong, percent	Avg	9.4		23.7		20.4		4.3			
	Min	7		23		9.5		2			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		9	(4)	8	(3)	10	(4)	9	(4)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1551	(225)	1626	(236)	1644	(238)	1119	(162)		
K_t = 6.3	Min	1455	(211)	1600	(232)	1531	(222)	1069	(155)		
No. of Spec. (No. of Heats)		6	(3)	8	(3)	6	(3)	6	(3)		
NTS, MN/m^2 (ksi)	Avg	1138	(165)			1117	(162)	958	(139)		
K_t = 19+	Min										
No. of Spec. (No. of Heats)		3	(1)			3	(1)	3	(1)		

References: 37146, 39429, 40953, 49088, 55111, 90081

TABLE 8.1.1-ME7.1

Alloy Designation: Type 301 Stainless Steel (Weld Metal) S30100

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet 60% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	957.7 (138.9)	1486 (215.5)		2006 (290.9)	1824 (264.5)	
	Min	924 (134)	1475 (214)		1965 (285)	1372 (199)	
Std. Deviation		21.9 (3.18)	6.7 (0.97)		30.2 (4.38)	216 (31.3)	
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	9.7	18.7		18.4	9.58	
	Min	8.5	16		15	3	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		13 (1)	13 (1)		13 (1)	13 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.1-ME7.2

Alloy Designation: Type 301 Stainless Steel S30100

Specification:
Form: Sheet
Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)
Condition: Cryogenically stretched at 77 K (-320 F)

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	1686 (244.5)			2138 (310.1)	1453 (355.8)	
	Min	1653 (239.8)			2123 (307.9)	2392 (346.9)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1649 (239.1)			2113 (306.4)	2418 (350.7)	
	Min	1618 (234.6)			2085 (302.4)	2356 (341.7)	
Std. Deviation							
Elong, percent	Avg	7.8			12.3	3.5	
	Min	7.0			9.0	2.8	
RA, percent	Avg	34.8			41.1	30.0	
	Min	28.9			35.9	27.4	
No. of Spec. (No. of Heats)		6 (1)			6 (1)	6 (1)	
E, GN/m² (10⁶ psi)	Avg	188 (27.2)			204 (29.6)	204 (29.6)	
	Min						
No. of Spec. (No. of Heats)		6 (1)			6 (1)	6 (1)	
Poisson's Ratio		0.32			0.28	0.37	
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	1662 (241.1)			2174 (315.3)	2435 (353.2)	
	Min	1624 (235.6)			2158 (313.0)	2408 (349.3)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1579 (229.0)			2077 (301.2)	2328 (337.7)	
	Min	1565 (227.0)			2051 (297.5)	2269 (329.1)	
Std. Deviation							
Elong, percent	Avg	7.1			11.6	3.3	
	Min	5.8			11.0	2.8	
RA, percent	Avg	28.1			31.1	11.0	
	Min	22.8			28.4	6.7	
No. of Spec. (No. of Heats)		6 (1)			6 (1)	5 (1)	
E, GN/m² (10⁶ psi)	Avg	190 (27.6)			204 (29.6)	205 (29.7)	
	Min						
No. of Spec. (No. of Heats)		6 (1)			6 (1)	5 (1)	
Poisson's Ratio		0.31			0.30	0.32	
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 82916

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TABLE 8.1.1-ME8

Alloy Designation: Type 301 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: *Annealed*

Testing Temperature, K (F)		297 (75)		166 (-160)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	958 (139)		1475 (214)	1860 (270)		2030 (294)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	53		33	32		26
	Min						
RA, percent	Avg	68		61	53		47
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	662 (96.0)		1300 (188)	993 (144)		924 (134)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.1-ME9

Alloy Designation: Type 301 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	133	(-220)	120	(-244)	73	(-328)	10	(-441)	
Compression, Longitudinal												
CYS, MN/m^2 (ksi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Ec, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Compression, Transverse												
CYS, MN/m^2 (ksi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Ec, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Shear(a)												
SUS, MN/m^2 (ksi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
G, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Impact, Charpy V, Testing Temp.												
Long., J(ft-lb)	Avg	294+	(217+)	294+	(217+)	144	(106)	144	(106)	111	(82)	
	Min											
No. of Spec. (No. of Heats)			(1)		(1)		(1)		(1)		(1)	
Trans., J(ft-lb)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Fracture Toughness(b)												
K_{Ic} $MN/m^{3/2}$ ($ksi\sqrt{in.}$)	Avg											
	Min											
Orientation —												
No. of Spec. (No. of Heats)												
K_{IE}, $MN/m^{3/2}$ ($ksi\sqrt{in.}$)	Avg											
(From PTSC spec.)(—)	Min											
No. of Spec. (No. of Heats)												

References: 52856

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 8.1.1-ME9.1

Alloy Designation: Type 301 Stainless Steel S30100

Specification:
Form: Plate-MIG welded, type 308 electrode
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate Welded, annealed 1366 K (2000 F) one hr, WQ, and tested as quenched

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	612 (88.7)	1082 (157.0)		1296 (188.0)		1269 (184.0)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	34.0	25.0		16.0		15.0
	Min						
RA, percent	Avg	58.0	41.0		21.0		19.5
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	648 (94.0)	858.4 (124.5)		941.1 (136.5)		1124 (163.0)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

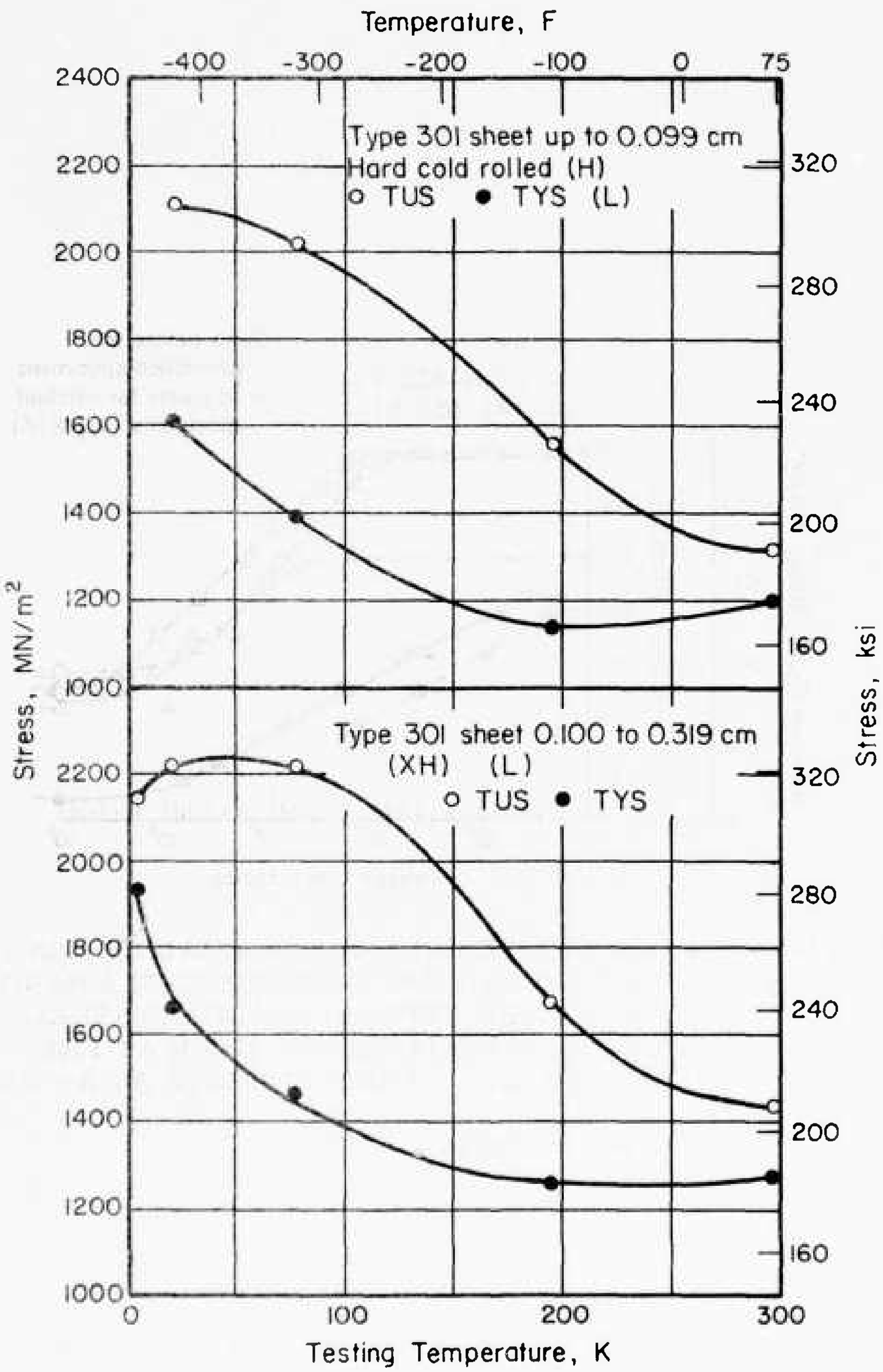

FIGURE 8.1.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 301 STAINLESS STEEL

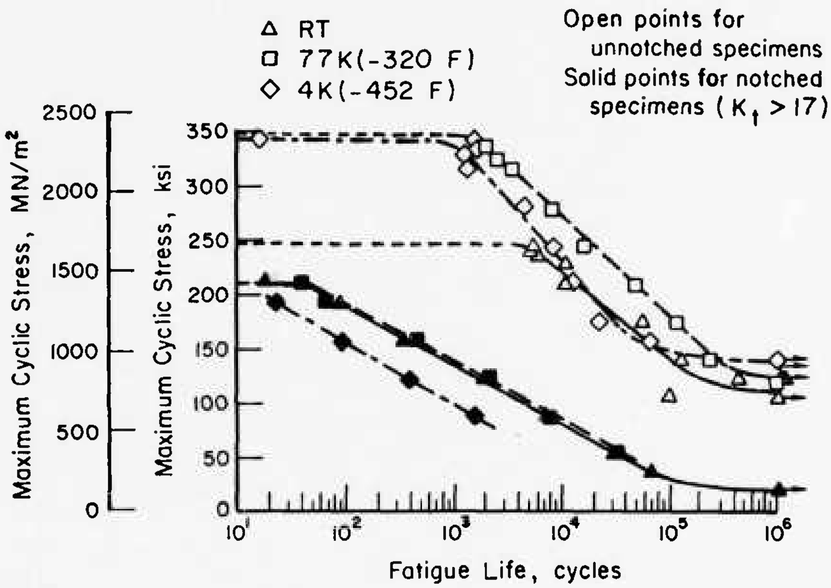

FIGURE 8.1.1-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING ON LONGITUDINAL SPECIMENS OF EXTRA HARD COLD ROLLED TYPE 301 STAINLESS STEEL SHEET 0.056 CM (0.022 IN.) THICK AT FREQUENCIES OF 3.3 AND 0.27 HERTZ AT R = 0.14

Reference: 70906

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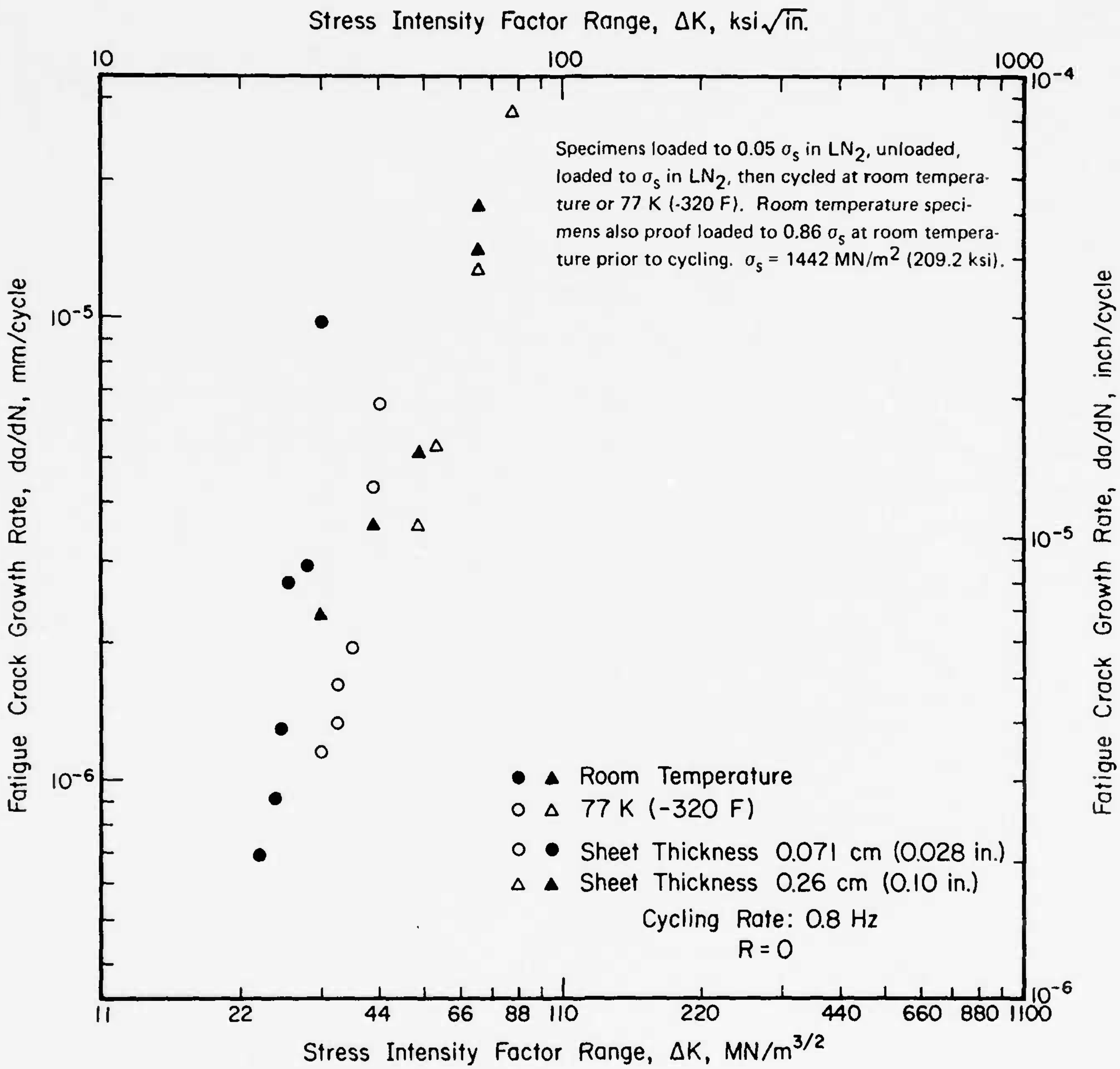

FIGURE 8.1.1-ME3. FATIGUE CRACK GROWTH RATE CURVES FOR SPECIMENS OF CRYOSTRETCHED 301 STAINLESS STEEL AT ROOM TEMPERATURE AND 77 K (-320 F) [87612]
[sheet cryostretched to 932 MN/m^2 (135 ksi) at 77 k (-320 F); simulated resin cure cycle 340 K (150 F) 3 hr + 420 K (300 F) 5 hr]

TABLE 8.1.1-TR1

Alloy Designation: Type 301 Stainless Steel

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.211	-0.230	-0.232		
No. of Spec.	2	2	1	1		
References: 48571, 90208						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

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TABLE 8.1.2-ME1

Alloy Designation: Type 304 Stainless Steel

Specification: AMS 5513, MIL-S-5059C
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Hard cold rolled

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	1320	(191)	1469	(213)	1904	(276)	2015	(292)		
	Min	1310	(190)	1455	(211)	1882	(273)	1910	(277)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	1193	(173)	1296	(188)	1434	(208)	1558	(226)		
	Min	1172	(170)	1248	(181)	1358	(197)	1462	(212)		
Std. Deviation											
Elong, percent	Avg	2.7		9.6		28.6		1.8			
	Min	2.5		8.5		28		1.5			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	6	(1)		
E, GN/m^2 (10^6 psi)	Avg	178	(25.9)	185	(26.9)	201	(29.1)	210	(30.5)		
	Min	174	(25.3)	182	(26.4)	198	(28.8)	204	(29.6)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1462	(212)	1593	(231)	1910	(277)	2158	(313)		
K_t = 6.3	Min	1420	(206)	1572	(228)	1889	(274)	2117	(307)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
NTS, MN/m^2 (ksi)	Avg	1158	(168)	1303	(189)	1620	(235)	1585	(230)		
K_t = 19+	Min	1117	(162)	1268	(184)	1565	(227)	1524	(221)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	1438	(209)	1601	(232)	1868	(271)	2155	(313)		
	Min	1427	(207)	1565	(227)	1848	(268)	2130	(309)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	1179	(171)	1331	(193)	1476	(214)	1558	(226)		
	Min	1165	(169)	1296	(188)	1462	(212)	1517	(220)		
Std. Deviation											
Elong, percent	Avg	4.9		7.1		22.9		1.3			
	Min	4.5		6.0		21.5		1.0			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
E, GN/m^2 (10^6 psi)	Avg	193	(28.0)	199	(28.9)	207	(30.0)	214	(31.1)		
	Min	189	(27.4)	195	(28.3)	204	(29.6)	209	(30.3)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1200	(174)	1400	(203)	1689	(245)	1903	(276)		
K_t = 6.3	Min	1144	(166)	1338	(194)	1668	(242)	1855	(269)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
NTS, MN/m^2 (ksi)	Avg	1124	(163)	1269	(184)	1544	(224)	1572	(228)		
K_t = 19+	Min	1062	(154)	1220	(177)	1462	(212)	1503	(218)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		

References: 56261

TABLE 8.1.2-ME1.1

Alloy Designation:	Type 304 Stainless Steel (Weld Metal)	S30400	
Specification:			
Form:	Sheet-TIG Welded, no filler		
Thickness, cm (in.):	Up to 0.099 (0.039)		
Condition:	70% cold rolled, welded, and tested as welded		

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	677 (98.2)	1220 (177)		1675 (243)	1827 (265)	
	Min	653 (94.7)	1200 (174)		1653 (240)	1806 (262	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.7	2.3		2.2	2.8	
	Min	1.0	2.0		1.5	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	703 (102)	1240 (180)		1717 (249)	2000 (290)	
	Min	684 (100)	1230 (179)		1710 (248)	1972 (286)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.3	2.0		2.3	2.7	
	Min	2.0	1.5		2.0	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 56261

TABLE 8.1.2-M22

Alloy Designation:	**Type 304 Stainless Steel**
Specification:	**AMS-5513, MIL-S-5059**
Form:	**Sheet**
Thickness, cm (in.):	**0.100 to 0.319 (0.040 to 0.125)**
Condition:	**Annealed**

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	**658 (95.5)**		**1627 (236)**	**1800 (261)**	**1703 (247)**	
	Min	655 (95.0)		1620 (235)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	**293 (42.5)**		**379 (55.0)**	**427 (62.0)**	**569 (82.5)**	
	Min	283 (41.0)		372 (54.0)	421 (61.0)	552 (80.0)	
Std. Deviation							
Elong, percent	Avg	**75**		**41.5**	**31**	**30**	
	Min	70		39	30	30	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (2)		4 (2)	4 (2)	4 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	**720 (104)**		**1444 (210)**	**1158 (168)**	**1227 (178)**	
K_t = 5.2	Min	710 (103)		1406 (204)	1089 (158)	1200 (174)	
No. of Spec. (No. of Heats)		4 (2)		4 (2)	4 (2)	4 (2)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48128

TABLE 8.1.2-ME3

Alloy Designation: Type 304 Stainless Steel — S30400

Specification: AMS-5513, MIL-S-5059
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	592.5 (85.93)		1586 (230)	1724.6 (250.13)		
	Min	587 (85.1)			1682 (244)		
Std. Deviation		11.4 (1.65)			17 (2.47)		
TYS, MN/m^2 (ksi)	Avg	328 (47.6)		377 (54.7)	410 (59.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	64		39			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (2)		1 (1)	8 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	564 (81.8)		1620 (235)	1482 (215)		
	Min	605 (87.7)					
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	318 (46.1)		401 (58.1)	364 (52.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	66.5		42			
	Min	66					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		1 (1)	1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 56754, 87223

TABLE 8.1.2-ME3.1

Alloy Designation: Type 304 Stainless Steel S30400

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297 (75)				20 (-423)	
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg	490 (71.1)				972.2 (141.0)	
	Min						
No. of Spec. (No. of Heats)		7 (1)				7 (1)	
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 56754

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 8.1.2-ME3.2

Alloy Designation:	Type 304 Stainless Steel S30400
Specification:	
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	20 (-423)				
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg		124 (91.5)				
	Min						
No. of Spec. (No. of Heats)			1				
Trans., Nm(ft-lb)	Avg		115 (85)				
	Min						
No. of Spec. (No. of Heats)			1				
Fracture Toughness[(b)]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{\text{in.}}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 94205

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 8.1.2-ME4

Alloy Designation: Type 304 Stainless Steel — S30400

Specification: AMS-5639A, QQ-S-763
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	122	(-240)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal													
TUS, MN/m^2 (ksi)	Avg	**640**	**(92.8)**	**1151**	**(167)**	**1338**	**(194)**	**1522**	**(221)**	**1864**	**(270)**	**1721**	**(250)**
	Min	572	(83.0)	1041	(151)			1420	(206)	1751	(254)	1668	(242)
Std. Deviation		52.6	(7.63)	41.3	(5.99)			91.7	(13.3)	99.3	(14.4)		
TYS, MN/m^2 (ksi)	Avg	**234**	**(33.9)**	**298**	**(43.2)**			**282**	**(40.9)**	**418**	**(60.6)**	**402**	**(58.2)**
	Min	179	(26.0)	276	(40.0)			200	(29.0)	358	(52.0)	379	(55.0)
Std. Deviation		26.7	(3.87)					49.6	(7.20)	40.9	(5.93)	15.1	(2.19)
Elong, percent	Avg	**75.8**		**50.3**		**46.0**		**45.0**		**26.9**		**30.1**	
	Min	50		46				41		12		26	
RA, percent	Avg	**81.8**		**75.8**		**73.9**		**66.5**		**53.5**		**55.3**	
	Min	76		75				55		50		49.8	
No. of Spec. (No. of Heats)		26	(7)	9	(3)	1	(1)	22	(6)	12	(4)	8	(2)
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg	**910**	**(132)**	**1584**	**(230)**			**1993**	**(289)**	**1741**	**(252)**	**1879**	**(272)**
K_t = 3	Min	903	(131)	1579	(229)			1951	(283)	1724	(250)	1813	(263)
No. of Spec. (No. of Heats)		8	(2)	9	(2)			7	(2)	8	(2)	4	(1)
NTS, MN/m^2 (ksi)	Avg	**708**	**(103)**					**1053**	**(153)**	**1117**	**(162)**		
K_t = 14	Min	703	(102)					1048	(152)	1089	(158)		
No. of Spec. (No. of Heats)		3	(1)					3	(1)	3	(1)		
Tension, Transverse													
TUS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
TYS, MN/m^2 (ksi)	Avg												
	Min												
Std. Deviation													
Elong, percent	Avg												
	Min												
RA, percent	Avg												
	Min												
No. of Spec. (No. of Heats)													
E, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m^2 (ksi)	Avg												
K_t =	Min												
No. of Spec. (No. of Heats)													

References: 39871, 45464, 48128, 64373, 90190

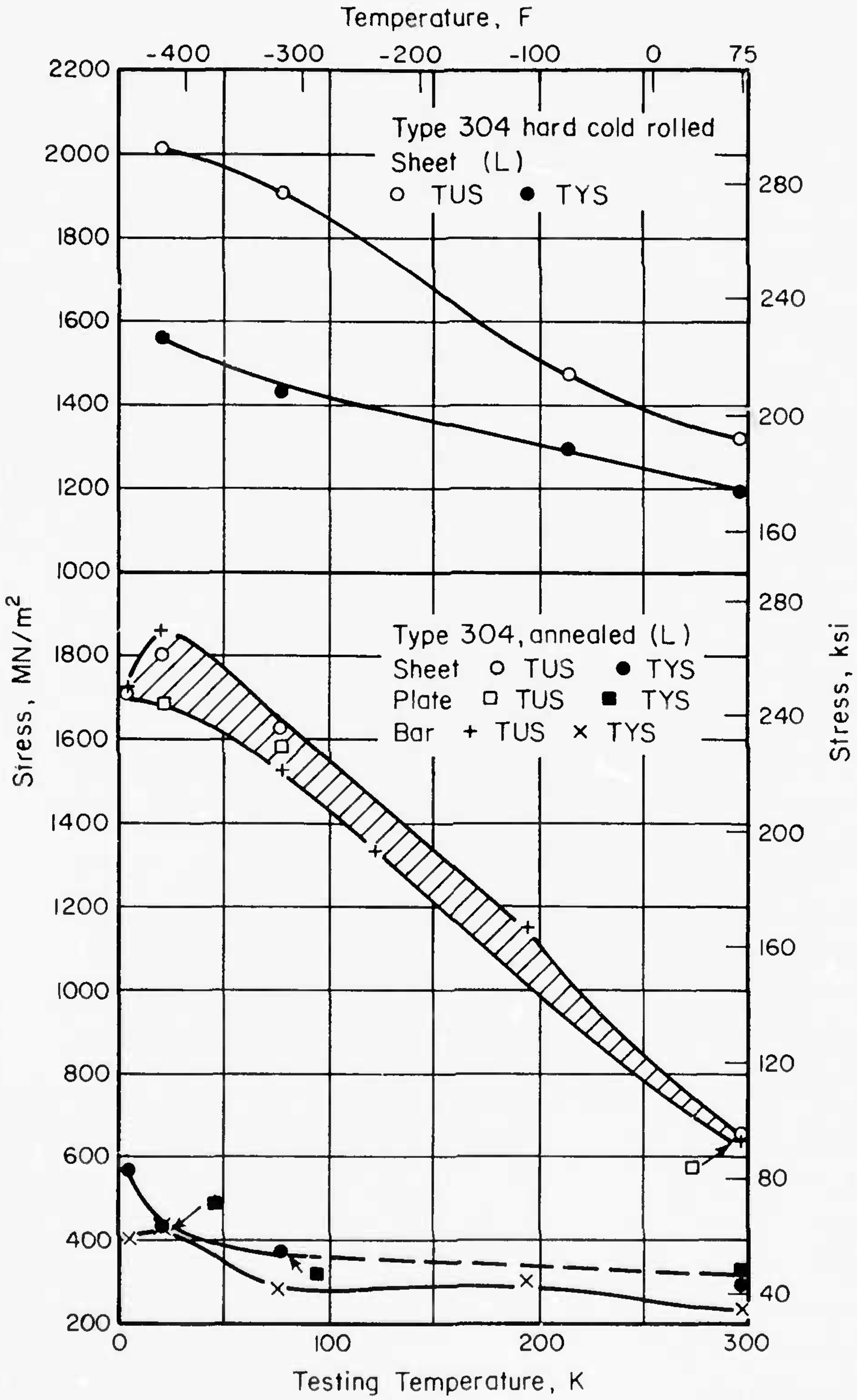

FIGURE 8.1.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 304 STAINLESS STEEL

TABLE 8.1.2-TR1

Alloy Designation: Type 304 Stainless Steel S30400

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	H tesla,	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity													
Watts m^{-1} K^{-1}		14.7		9.5		5.7		1.95		0.78			
Btu hr^{-1} ft^{-1} F^{-1}			(8.50)		(5.49)		(3.30)		(1.13)		(0.451)		
No. of Spec.		1		1		1		1		1			
References: 40911													
Thermal Expansion (T_{273} to T) Longitudinal													
Percent		0		-0.230		-0.261		-0.264		-0.264		-0.264	
No. of Spec.		2		2		2		2		2		2	
References: 90208, 90336													
Specific Heat													
Joules kg^{-1} K^{-1}													
Btu lb^{-1} F^{-1}													
No. of Spec.													
References:													
Electrical Resistivity													
Ohm m													
Ohm circular mil ft^{-1}													
No. of Spec.													
References: 79561													
Magnetothermal Conductivity													
Watts m^{-1} K^{-1}	0							2.20		0.95		0.40	
Btu hr^{-1} ft^{-1} F^{-1}									(1.27)		(0.55)		(0.23)
Watts m^{-1} K^{-1}	8							2.00		0.90		0.35	
Btu hr^{-1} ft^{-1} F^{-1}									(1.16)		(0.52)		(0.20)
No. of Spec.								1		1		1	
References: 95168													

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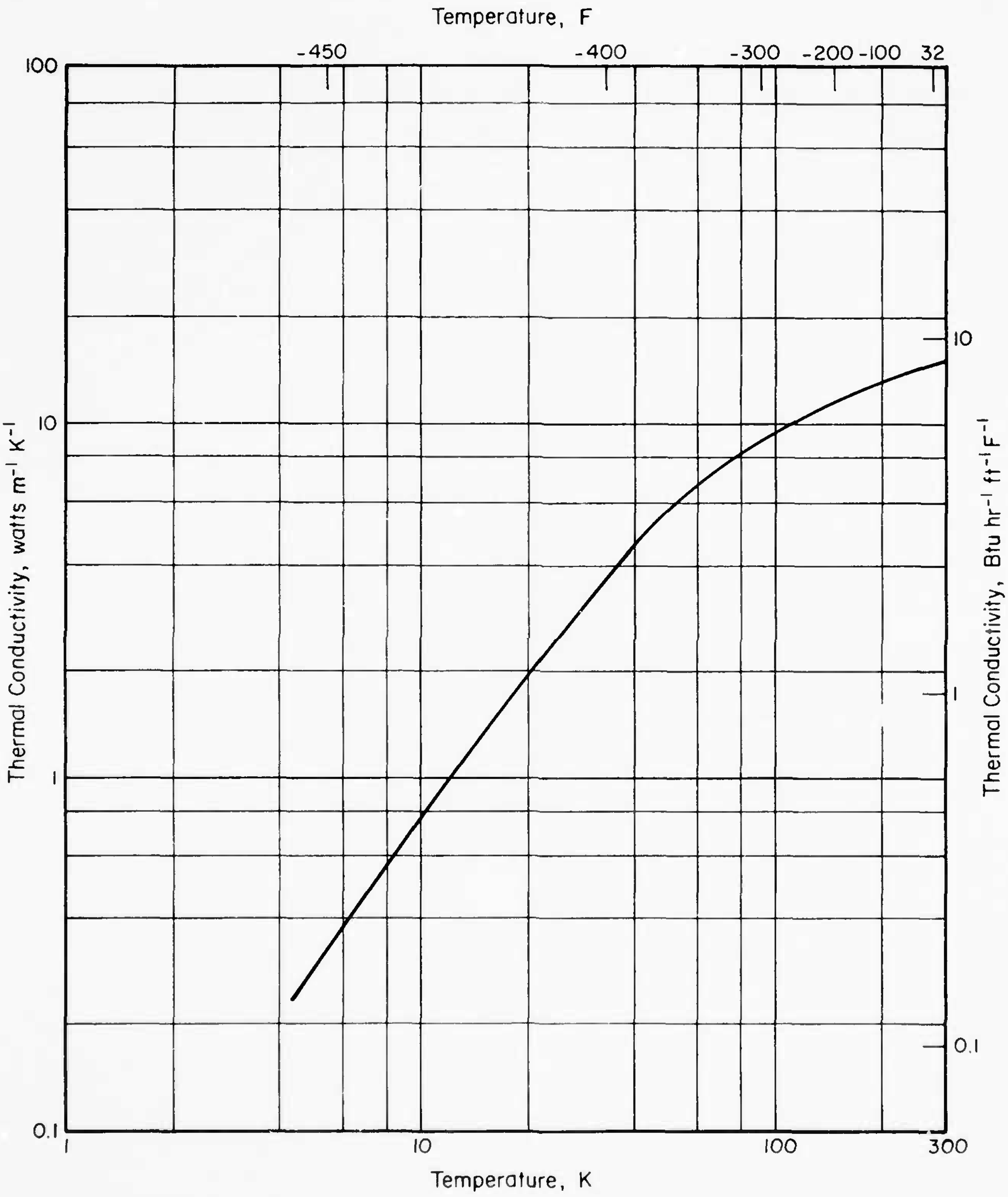

FIGURE 8.1.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 304 STAINLESS STEEL

Type 304

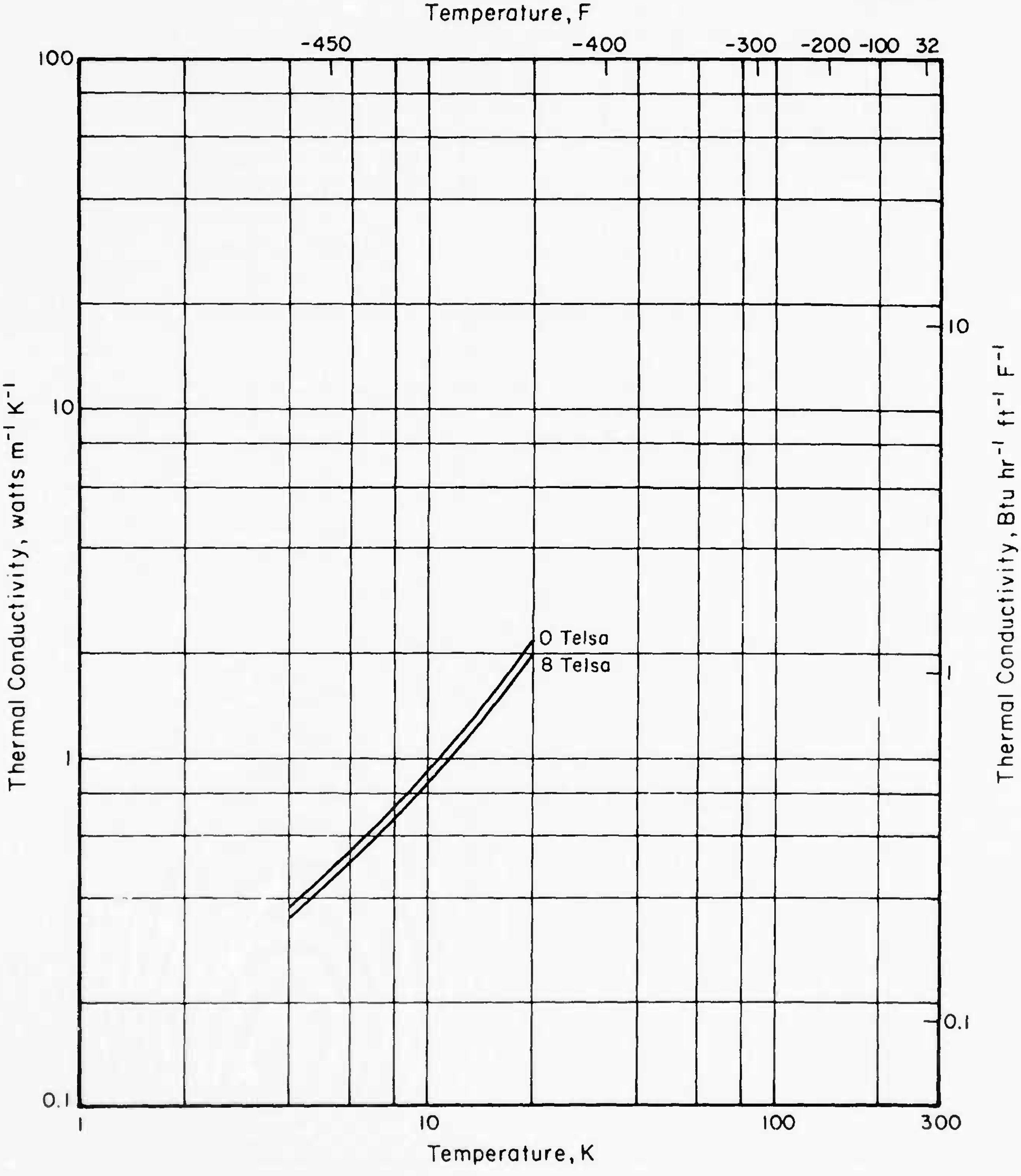

FIGURE 8.1.2-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 304 STAINLESS STEEL AT DIFFERENT MAGNETIC FIELD STRENGTHS

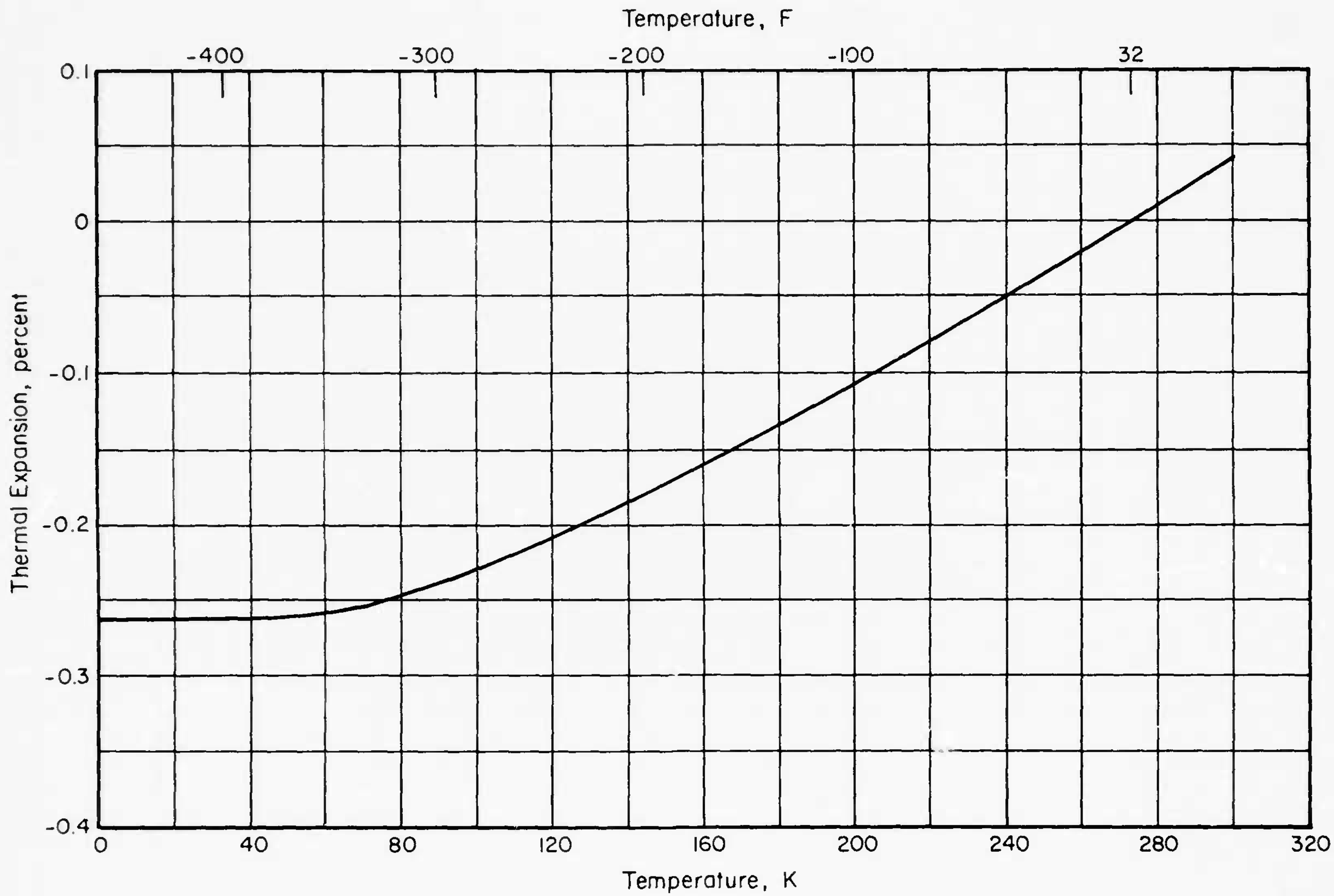

FIGURE 8.1.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 304 STAINLESS STEEL

TABLE 8.1.3-ME0.1

Alloy Designation:	Type 304L Stainless Steel S40503
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	Cold rolled 50%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1241 (180)	1379 (200)	1669 (242)	1896 (275)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1089 (158)	1234 (179)	1344 (195)	1613 (234)		
	Min						
Std. Deviation							
Elong, percent	Avg	2.5	4.5	76.5	1.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5	5	5	5		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1372 (199)	1510 (219)	1841 (267)	2137 (310)		
K_t =	Min						
No. of Spec. (No. of Heats)		5	5	5	5		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94204

TABLE 8.1.3-ME0.2

Alloy Designation: Type 304L Stainless Steel (Weld Metal) S40503

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Sheet 50% cold reduced, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	570 (82.6)	1007 (146.0)		1502 (217.9)	1757 (254.9)	
	Min	523 (75.9)	958 (139)		1480 (215)	1710 (248)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.9	2.5		3.3	3.4	
	Min	1.5	1.5		2.0	3.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	549 (79.6)	988.7 (143.4)		1487 (215.7)	1882 (272.9)	
	Min	496 (71.9)	924 (134)		1380 (200)	1800 (261)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6	2.5		2.9	3.5	
	Min	1	2		2	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48652, 49088

TABLE 8.1.3-ME0.3

Alloy Designation: Type 304L Stainless Steel S40503

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: 70% cold reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	1320 (191)			1780 (258)	2050 (298)	
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1210 (176)			1630 (237)	1810 (262)	
	Min						
Std. Deviation							
Elong, percent	Avg	2.0			1.5	1.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	1490 (216)			1930 (280)	2270 (329)	
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg	1250 (182)			1700 (247)	2040 (296)	
	Min						
Std. Deviation							
Elong, percent	Avg	3.0			2.0	0.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME1

Alloy Designation:	**Type 304L Stainless Steel** S40503
Specification:	AMS-5511A, MIL-S-4043
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	**661**	**(95.9)**	**977**	**(142)**	**1464**	**(212)**	**1748**	**(254)**	**1589**	**(230)**
	Min	620	(90.0)	896	(130)	1406	(204)	1738	(252)	1538	(223)
Std. Deviation		27.2	(3.95)	60.4	(8.76)	34.7	(5.03)	12.2	(1.77)	43.0	(6.23)
TYS, MN/m^2 (ksi)	Avg	**295**	**(42.8)**	**248**	**(36.0)**	**273**	**(39.6)**	**307**	**(44.5)**	**403**	**(58.5)**
	Min	262	(38.0)	200	(29.0)	200	(29.0)	200	(29.0)	317	(46.0)
Std. Deviation		16.6	(2.41)	43.3	(6.28)	43.6	(6.32)	65.3	(9.48)	47.1	(6.83)
Elong, percent	Avg	**55.8**		**42.8**		**36.8**		**33.2**		**29.3**	
	Min	42		42		33		27		24	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		16	(4)	8	(2)	16	(4)	8	(4)	12	(4)
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	**734**	**(106)**	**1030**	**(150)**	**1417**	**(206)**	**1287**	**(187)**	**1460**	**(212)**
K_t = 5.2	Min	634	(92.0)	1027	(149)	1351	(196)	1227	(178)	1386	(201)
No. of Spec. (No. of Heats)		16	(4)	4	(1)	16	(4)	14	(4)	12	(3)
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg									**1536**	**(223)**
	Min									1400	(203)
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg									**410**	**(59.5)**
	Min									386	(56.0)
Std. Deviation											
Elong, percent	Avg									**34.8**	
	Min									34	
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)										5	(1)
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 48128, 77930

TABLE 8.1.3-ME1.1

Alloy Designation: Type 304L Stainless Steel S40503

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: 40% coid reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1030 (150)			1720 (250)	1630 (236)	
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	793 (115)			1030 (150)	1160 (168)	
	Min						
Std Deviation							
Elong, percent	Avg	7.5			30.5	31.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1090 (158)			1680 (244)	1510 (219)	
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	924 (134)			1100 (160)	1200 (174)	
	Min						
Std Deviation							
Elong, percent	Avg	8.5			32.0	--	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME2.1

Alloy Designation:	Type 304L Stainless Steel S40503
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	60% reduced reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1270 (184)			1790 (260)	1770 (256)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1010 (146)			1260 (183)	1520 (221)	
	Min						
Std. Deviation							
Elong, percent	Avg	5.5			28.5	5.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1300 (188)			1720 (250)	1840 (267)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1100 (160)			1390 (202)	1670 (242)	
	Min						
Std. Deviation							
Elong, percent	Avg	6.2			25.8	2.2	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME1.3

Alloy Designation: Type 304L Stainless Steel S40503

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: 70% cold reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1330 (193)			1760 (255)	1920 (279)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	938 (136)			1430 (208)	1720 (249)	
	Min						
Std. Deviation							
Elong, percent	Avg	4.0			26.0	2.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1390 (202)			1850 (269)	2210 (320)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1190 (172)			1550 (225)	1840 (267)	
	Min						
Std. Deviation							
Elong, percent	Avg	4.5			23.0	1.7	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME1.4

Alloy Designation:	Type 304L Stainless Steel	S40503

Specification:
Form: Plate
Thickness, cm (in.): Over 5.080 (2.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg		90.8 (67)	89.5 (66)			
	Min						
No. of Spec. (No. of Heats)			1	1			
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 94205

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 8.1.3-ME2

Alloy Designation: Type 304L Stainless Steel

Specification: AMS-5647B, QQ-S-763
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	659	(95.5)	1055	(153)	1509	(219)	1882	(273)	1660	(241)
	Min	572	(83.0)	1048	(152)	1427	(207)	1882	(273)	1620	(235)
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	406	(58.9)	433	(62.8)	460	(66.6)	522	(75.8)	547	(79.4)
	Min	391	(56.7)	421	(61.1)	453	(65.7)	520	(75.4)	537	(77.9)
Std. Deviation											
Elong, percent	Avg	78.0		69.8		42.9		42.1		33.9	
	Min	77		67.6		42.3		36.7		33.6	
RA, percent	Avg	81.2		73.9		65.9		41.2		55.6	
	Min	79		71		61		38.6		54.0	
No. of Spec. (No. of Heats)		5	(3)	4	(2)	6	(3)	4	(2)	5	(3)
E, GN/m^2 (10^6 psi)	Avg	190	(27.6)			205	(29.7)			201	(29.2)
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
Elong, percent	Avg										
	Min										
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)											
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 48128, 54986, 89543

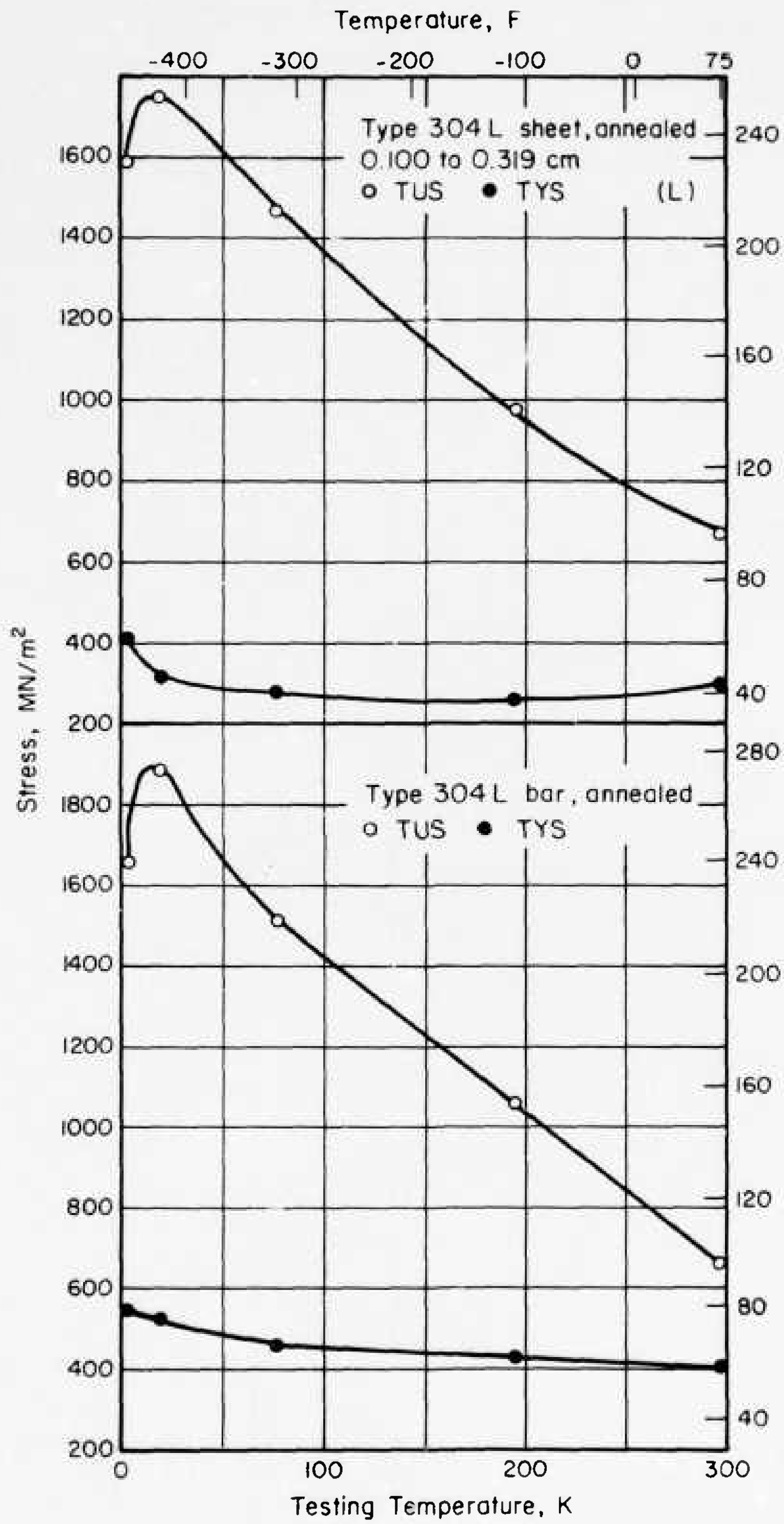

FIGURE 8.1.3-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 304L STAINLESS STEEL

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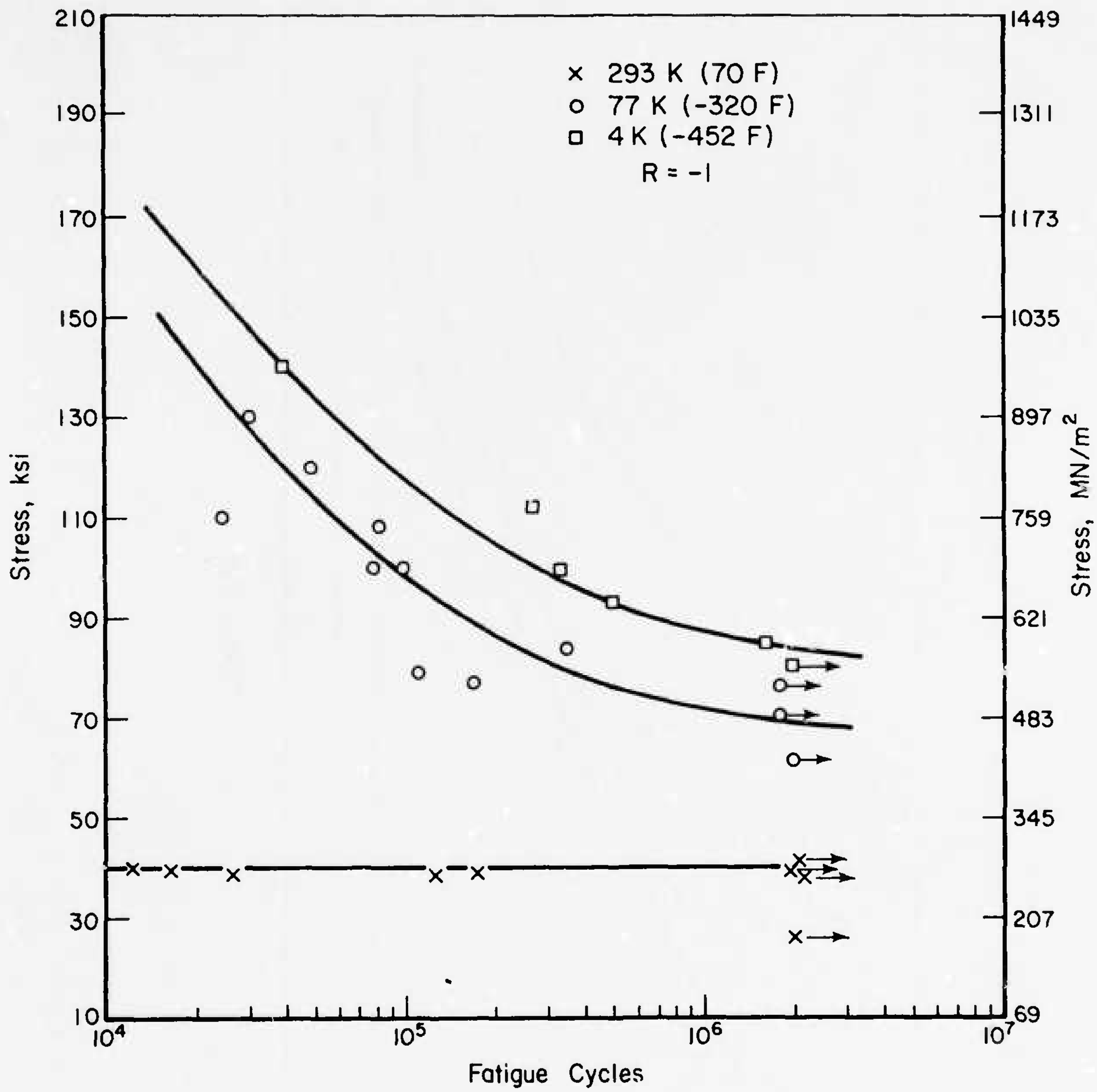

FIGURE 8.1.3-ME2. AXIAL FATIGUE LIFE CURVES FOR SMOOTH 304L STAINLESS STEEL BAR [Up to 2.540 cm (1.000 in.) diameter] [95168]

57?

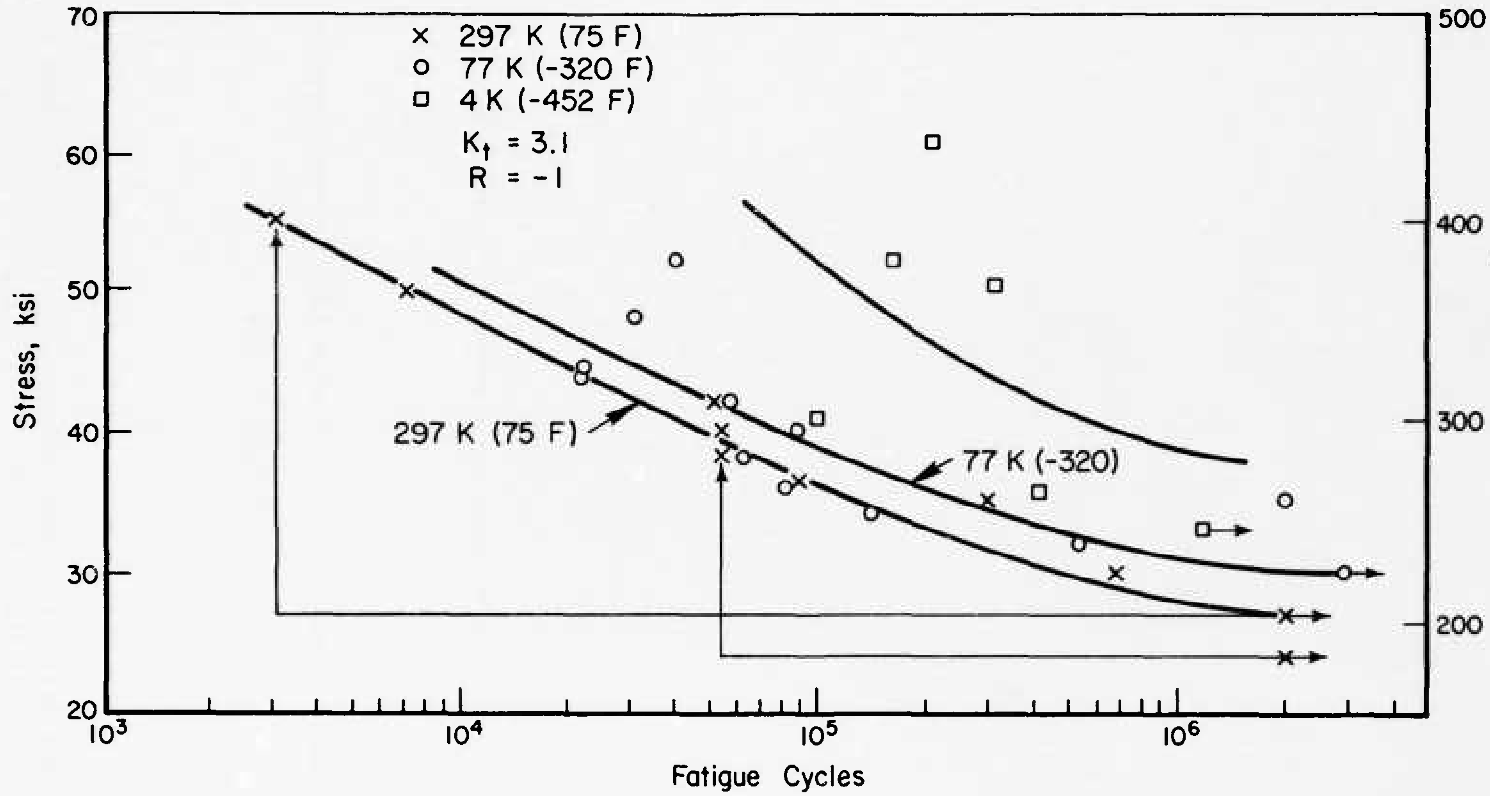

FIGURE 8.1.3-ME2.1. AXIAL FATIGUE LIFE CURVES FOR NOTCHED ANNEALED 304L STAINLESS STEEL BAR [95168]
[Up to 2.540 cm (1.000 in.) diameter]

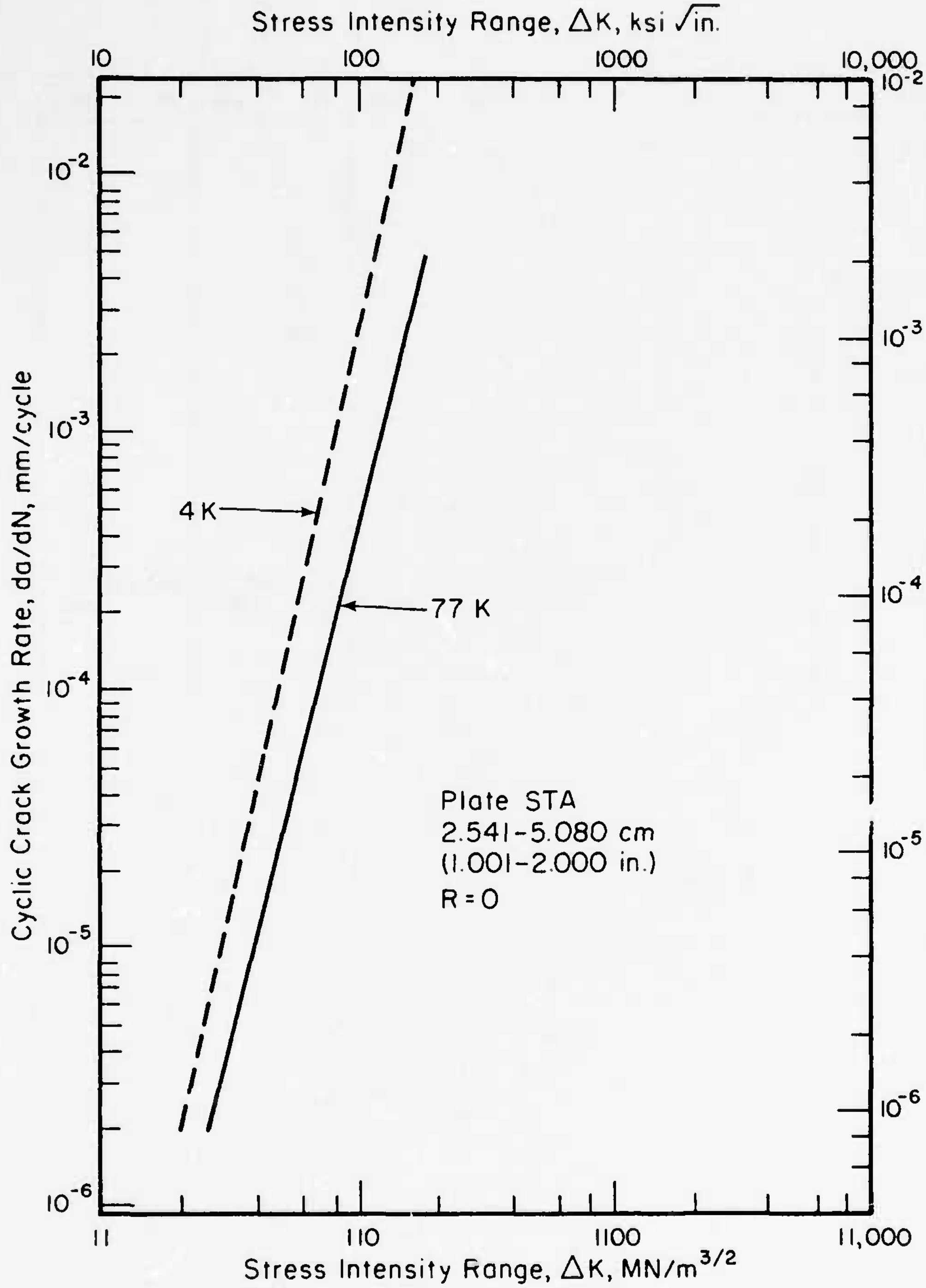

FIGURE 8.1.3-ME3. FATIGUE CRACK GROWTH RATE PROPERTIES OF 304L STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94206A)

TABLE 8.1.3-TR1

Alloy Designation: Type 304L Stainless Steel S40503

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.234	-0.268	-0.275		
No. of Spec.	1	1	1	1	1	
References: 48134						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	70.0×10^{-8}	54.5×10^{-8}	50.5×10^{-8}	49.0×10^{-8}	49.0×10^{-8}	49.0×10^{-8}
Ohm circular mil ft^{-1}	(421)	(328)	(304)	(295)	(295)	(295)
No. of Spec.	1	1	1	1	1	1
References:						

58[illegible]

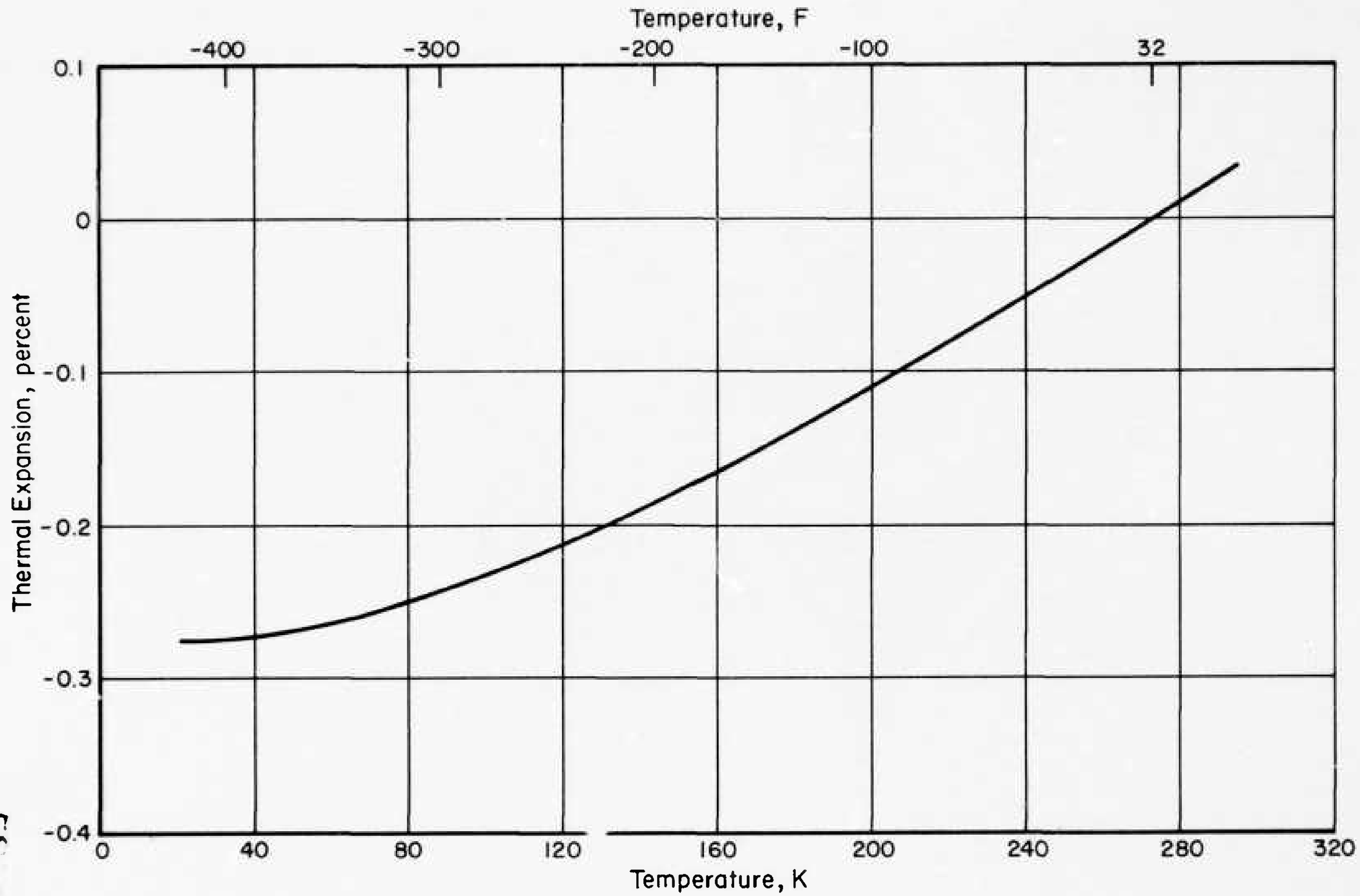

FIGURE 8.1.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 304L STAINLESS STEEL

TABLE 8.1.4-ME0.1

Alloy Designation: Type 310 Stainless Steel — S31000

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Cold rolled 40%

Testing Temperature, K (F)		297 (75)	196 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1051.5 (152.5)	1174 (170.3)	1515.5 (219.8)	1873 (271.7)		
	Min	1048 (152)	1172 (170)	1496 (217)	1806 (262)		
Std. Deviation		--	--	--	--		
TYS, MN/m^2 (ksi)	Avg	949.4 (137.7)	1075.6 (156)	1248 (181)	1382 (200.5)		
	Min	944.6 (137.7)	1048 (152)	1192.8 (173)	1255 (182)		
Std. Deviation		--	--	--	--		
Elong, percent	Avg	3.5	13.3	24.0	28.5		
	Min	3.0	13.0	22.0	28.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	4 (1)	5 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1197.6 (173.7)		1629 (236.3)	1898 (275.3)		
K_t = 6.3	Min	1151.4 (167)		1599.6 (232)	1896 (275)		
No. of Spec. (No. of Heats)		6 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg		1237.6 (179.5)		1813.3 (263)		
	Min		1234.2 (179)		1806.4 (262)		
Std. Deviation			--		--		
TYS, MN/m^2 (ksi)	Avg		1037.6 (150.5)		1503 (218)		
	Min		1027.3 (149)		(218)		
Std. Deviation			--		--		
Elong, percent	Avg		11.5		25.5		
	Min		11.0		25.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			2 (1)		2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg				2023 (293.5)		
K_t = 6.3	Min				2006 (291)		
No. of Spec. (No. of Heats)					2 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.4-ME0.2

Alloy Designation: Type 310 Stainless Steel S31000

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Cold rolled 60%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1202 (174.3)		1608.5 (233.3)	1903 (276)		
	Min	1165 (169)		1606.5 (233)	1875 (272)		
Std. Deviation		--		--	--		
TYS, MN/m^2 (ksi)	Avg	1055 (153)		1413 (205)	1603 (232.5)		
	Min	1048 (152)		1386 (201)	1593 (231)		
Std. Deviation							
Elong, percent	Avg	3.33		17.0	18.50		
	Min	3.00		17.00	18.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1243 (180.3)		1708 (247.7)	2041 (296)		
K_t = 6.3	Min	1234 (179)		1703 (247)	2034 (295)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg				1968 (285.5)		
	Min				1958 (284)		
Std. Deviation					--		
TYS, MN/m^2 (ksi)	Avg				1562 (226.5)		
	Min				1482 (215)		
Std. Deviation					--		
Elong, percent	Avg				16.00		
	Min				16.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)					2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg				2123 (308)		
K_t = 6.3	Min				2103 (305)		
No. of Spec. (No. of Heats)					2 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.4-ME0.3

Alloy Designation: Type 310 Stainless Steel S31000

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Cold rolled 75%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	1178.6 (170.94)	1404 (203.63)	1718.6 (249.27)	2002 (290.39)		
	Min	1220 (177)	1386 (201)	1654.7 (240)	1930.5 (280)		
Std. Deviation		163.5 (38.22)	9.7 (1.41)	35 (5.08)	37 (5.40)		
TYS, MN/m² (ksi)	Avg	1100.9 (159.67)	1289 (187)	1535.5 (222.7)	1786 (259)		
	Min	1048 (152)	1255 (182)	1448 (210)	1737.5 (252)		
Std. Deviation		30.8 (4.47)	31.9 (4.63)	44.3 (6.42)	33.9 (4.92)		
Elong, percent	Avg	2.64	4.38	10.23	10.42		
	Min	2.0	2.00	8.00	1.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		18 (3)	8 (2)	11 (3)	18 (3)		
E, GN/m² (10⁶ psi)	Avg	175 (25.4)	175.8 (25.5)	182 (26.4)	195 (28.3)		
	Min	162 (23.5)	165.5 (24.0)	175.8 (25.5)	186.8 (27.1)		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	1356 (196.7)	1530.6 (222)	1901 (275.7)	2230 (323.5)		
K_t = 6.3	Min	1337.6 (194)	1496 (217)	1848 (268)	2144 (311)		
No. of Spec. (No. of Heats)		15 (3)	8 (2)	11 (2)	15 (3)		
NTS, MN/m² (ksi)	Avg	1107 (160.6)	1270 (184.2)	1473 (213.6)	1446.5 (209.8)		
K_t = 19+	Min	1048 (152)	1151 (167)	1317 (191)	1303 (189)		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	1375 (199.36)	1544 (224.0)	1878 (272.43)	2145.6 (311.19)		
	Min	1358 (197)	1537.5 (223)	1861.6 (270)	2054.6 (298)		
Std. Deviation		9.6 (1.39)	--	--	47.5 (6.89)		
TYS, MN/m² (ksi)	Avg	1107 (160.6)	1291.4 (187.3)	1526 (22.13)	1796 (260.5)		
	Min	1048 (152)	1213.5 (176)	1475.5 (214)	1668.5 (242)		
Std. Deviation		25.2 (3.64)	--	--	82.7 (11.99)		
Elong, percent	Avg	3.71	7.43	9.50	9.37		
	Min	3.00	6.50	7.50	1.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		14 (3)	7 (2)	7 (2)	16 (3)		
E, GN/m² (10⁶ psi)	Avg	194 (28.1)	190 (27.6)	194 (28.2)	201 (29.12)		
	Min	186 (27.0)	179.3 (26.0)	187.5 (27.2)	187 (27.1)		
No. of Spec. (No. of Heats)		4 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	1370.7 (198.8)	1639.6 (237.8)	2045 (296.6)	2196 (318.5)		
K_t =	Min	1303 (189)	1558 (226)	1993 (289)	1999.5 (290)		
No. of Spec. (No. of Heats)		11 (3)	7 (2)	7 (2)	13 (3)		
NTS, MN/m² (ksi)	Avg	834.3 (121)	1097.6 (159.2)	1209 (175.4)	1322 (191.8)		
K_t =	Min	799.8 (116)	1013.5 (147)	1110 (161)	1186 (172)		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		

References: 39429, 48652, 59901

TABLE 8.1.4-ME0.4

Alloy Designation: Type 310 Stainless Steel (Weld Metal) S31000

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Sheet 75% cold reduced, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	601 (87.2)	758 (110)		1120 (163)	1420 (206)	
	Min	592 (85.8)	731 (106)		1090 (158)	1380 (200)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.9	2.2		2.3	2.1	
	Min	1	2		2	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	596 (86.5)	765 (111)		1150 (167)	1340 (195)	
	Min	571 (82.8)	752 (109)		1140 (166)	1290 (187)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.9	2.1		2.2	2.0	
	Min	1	2		2	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 48652, 49088

TABLE 8.1.4-ME0.5

Alloy Designation: Type 310 Stainless Steel   S31000

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: 80-85% cold worked

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1310 (190)				2060 (299)	
	Min	1300 (188)				2030 (295)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1150 (167)				1740 (253)	
	Min	1140 (166)				1720 (249)	
Std. Deviation							
Elong, percent	Avg	2.3				8.1	
	Min	2.0				6.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)				6 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1370 (198)				2170 (315)	
K_t = 6.3	Min	1330 (193)				2090 (303)	
No. of Spec. (No. of Heats)		4 (1)				6 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49971

TABLE 8.1.4-ME0.6

Alloy Designation: Type 310 Stainless Steel S31000

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: 90-92% Cold worked

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1370 (199)				2140 (310)	
	Min	1360 (198)				2120 (307)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1170 (170)				1840 (267)	
	Min	1150 (167)				1810 (262)	
Std. Deviation							
Elong, percent	Avg	1.3				4.9	
	Min	1.0				4.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (1)				7 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1360 (197)				2040 (296)	
K_t = 6.3	Min	1320 (191)				1800 (261)	
No. of Spec. (No. of Heats)		6 (1)				7 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49971

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TABLE 8.1.4-ME2.1

Alloy Designation: Type 310 Stainless Steel — S31000

Specification: AMS 5521B
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Cold rolled 3/4 hard

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1127 (163.5)	1267 (183.8)		1619 (234.8)	1686 (244.5)	
	Min	1124 (163.0)	1258 (182.5)		1603 (232.5)	1669 (242.0)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1027 (149.0)	1140 (165.4)		1444 (209.5)	1551 (225.0)	
	Min	979.1 (142.0)	1111 (161.2)		1434 (208.0)	1517 (220.0)	
Std. Deviation							
Elong, percent	Avg	3.2	7.2		12.8	2.0	
	Min	2.5	7.0		12.5	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg	211 (30.6)	217 (31.5)		223 (32.4)	230 (33.4)	
	Min	211 (30.6)	216 (31.3)		219 (31.8)	230 (33.3)	
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio		0.29	0.30		0.20	0.20	
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1226 (177.8)	1356 (196.6)		1636 (237.3)	1775 (257.5)	
	Min	1214 (176.1)	1342 (194.7)		1627 (236.0)	1772 (257.0)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1000 (145.1)	1059 (153.6)		1384 (200.8)	1595 (231.3)	
	Min	987.3 (143.2)	999.7 (145.0)		1379 (200.0)	1575 (228.5)	
Std. Deviation							
Elong, percent	Avg	3.8	6.5		9.1	2.5	
	Min	2.1	4.0		6.5	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg	210 (30.5)	214 (31.0)		222 (32.3)	215 (31.2)	
	Min	210 (30.4)	214 (31.0)		221 (32.1)	214 (31.0)	
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio		0.30	0.30		0.30	0.30	
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61688

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TABLE 8.1.4-ME2.2

Alloy Designation: Type 310 Stainless Steel (Weld Metal) S31000

Specification: AMS 5521B
Form: Sheet-TIG welded, 310 stainless-steel filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Cold rolled to 3/4 hard, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	530 (76.8)	722.6 (104.8)		1026 (148.8)		
	Min	514 (74.6)	713.6 (103.5)		1017 (147.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	380 (55.1)	523 (75.9)		751.5 (109.0)		
	Min	362 (52.5)	517 (75.0)		751.5 (109.0)		
Std. Deviation							
Elong, percent	Avg	4.3	3.8		4.0		
	Min	4.0	3.5		4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m^2 (10^6 psi)	Avg	181 (26.2)	187 (27.1)		199 (28.8)		
	Min	179 (26.0)	184 (26.7)		194 (28.1)		
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
Poisson's Ratio		0.32	0.33		0.29		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61688

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TABLE 8.1.4-ME3

Alloy Designation:	**Type 310 Stainless Steel**
Specification:	
Form:	**Plate**
Thickness, cm (in.):	**1.270 to 2.540 (0.500 to 1.000)**
Condition:	**Annealed**

Testing Temperature, K (F)		297 (75)		170 (-154)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	569 (82.5)		793 (115)	1096 (159)		1303 (189)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	60		79	80		63
	Min						
RA, percent	Avg	78.5		75.5	69.5		55.0
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)	(1)	(1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	752 (109)		1014 (147)	1365 (198)		1654 (240)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.4-ME3.1

Alloy Designation:	Type 310 Stainless Steel (Weld Metal) S31000
Specification:	
Form:	Plate-MIG welded, type 310-covered electrode
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000
Condition:	Plate welded, weldment annealed 1422 K (2100 F) 1 hr, WQ, tested as quenched

Testing Temperature, K (F)		297 (75)	168 (-156)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	564 (81.8)	810.1 (117.5)		1095 (158.8)		1271 (184.4)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	62.0	66.0		61.0		50.0
	Min						
RA, percent	Avg	78.0	75.0		52.0		47.0
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	755.0 (109.5)	996.3 (144.5)		1303 (189.0)		1641 (238.0)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.4-ME3.2

Alloy Designation:	Type 310 Stainless Steel	S31000
Specification:		
Form:	Plate	
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)	
Condition:	Annealed	

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	545 (79)	1055 (153)	1179 (171)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	241 (35)	545 (79)	765 (111)			
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2	1			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94206B

TABLE 8.1.4-ME3.3

Alloy Designation:	**Type 310 Stainless Steel**	**S31000**
Specification:		
Form:	**Plate**	
Thickness, cm (in.):	**Over 5.080 (2.000)**	
Condition:	**Annealed**	

Testing Temperature, K (F)		297 (76)	77 (-320)	20 (-423)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg		122 (90)	117 (86.5)			
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg		118 (87)	115 (85)			
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 94205

(a) **Indicate specimen design and orientation for shear specimens:**
(b) **Indicate specimen design for K_{Ic} data:**

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TABLE 8.1.4-ME4

Alloy Designation: Type 310 Stainless Steel — S31000

Specification:
Form: Bar
Diameter: Up to 2.540 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)	
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	585	(84.8)	738	(107)	1091	(158)	1390	(201.6)	1303	(189)	
	Min	542	(78.6)	738	(107)	1082	(157)	1248	(181)	1289	(187)	
Std. Deviation		23	(3.35)					103.4	(15.0)			
TYS, MN/m^2 (ksi)	Avg	338	(49.07	303	(43.9)	520	(75.5)	851.5	(123.5)	717	(104)	
	Min	217	(31.5)	300	(43.5)	512	(74.3)	685	(99.3)	703	(102)	
Std. Deviation		112.6	(16.33					138	(20.02)			
Elong, percent	Avg	49.7		71.5		67.7		44.0		49.8		
	Min	42.0		69.8		66.6		41.9				
RA, percent	Avg	75.6		68.0		49.6		48.5		41.0		
	Min	70.2		67.7		46.2		34.1				
No. of Spec. (No. of Heats)		9	(3)	2	(1)	3	(2)	8	(2)	2	(1)	
E, GN/m^2 (10^6 psi)	Avg					206	(29.9)			206	(29.9)	
	Min											
No. of Spec. (No. of Heats)						3	(1)			3	(1)	
Poisson's Ratio		0.287				0.303				0.296		
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg	779	(113)	986	(143)	1441	(209)	1772	(257)	1786	(259)	
K_t = 3	Min											
No. of Spec. (No. of Heats)		2	(1)	2	(1)	2	(1)	2	(1)	2	(1)	
NTS, MN/m^2 (ksi)	Avg	775	(112.4					1300	(188.6)			
K_t = 6.4	Min	758	(110.0					1089	(158.0)			
No. of Spec. (No. of Heats)		5	(1)					5	(1)			
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg											
	Min											
Std. Deviation												
Elong, percent	Avg											
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 54986, 64373, 89543

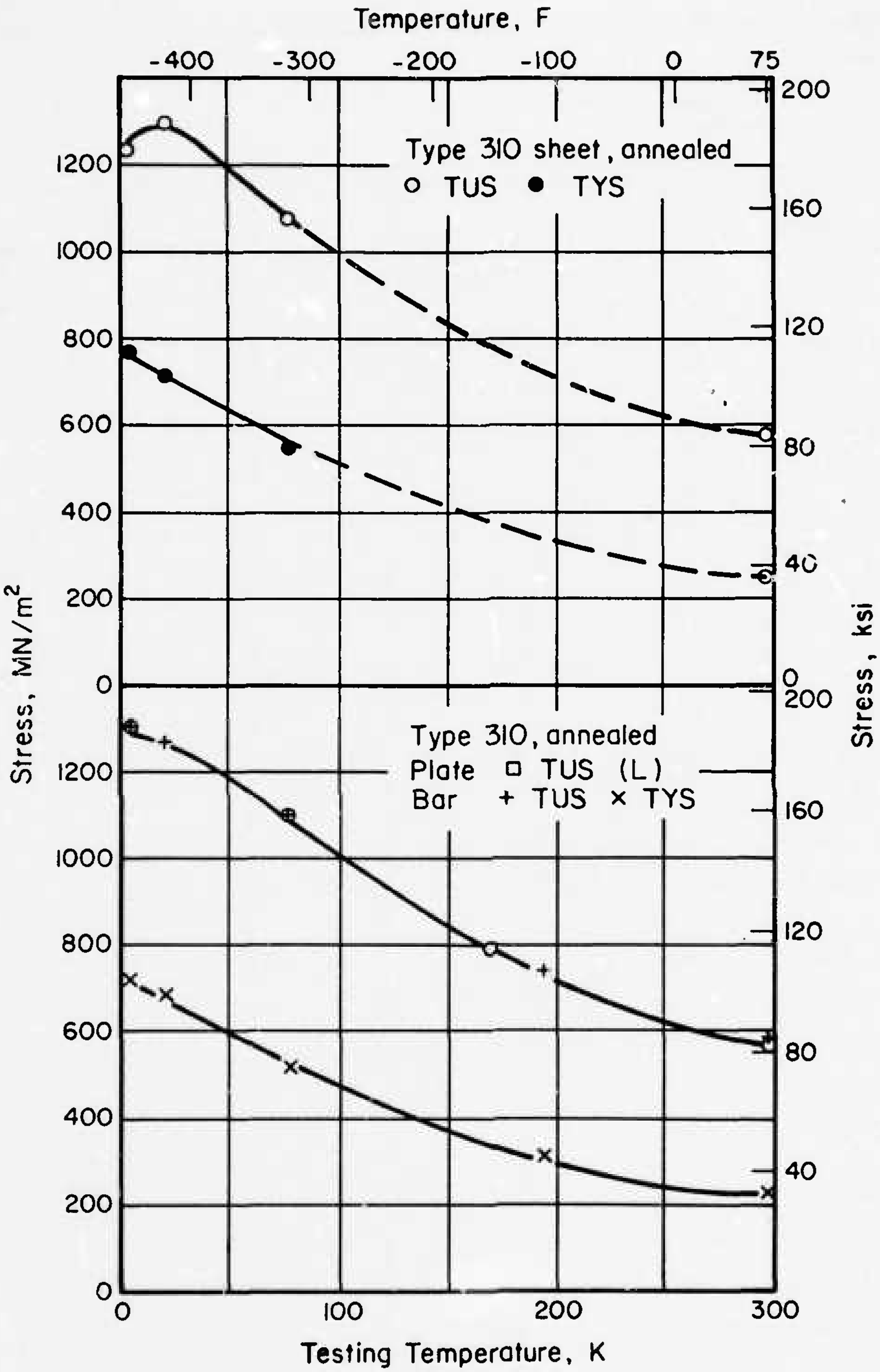


FIGURE 8.1.4-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 310 STAINLESS STEEL

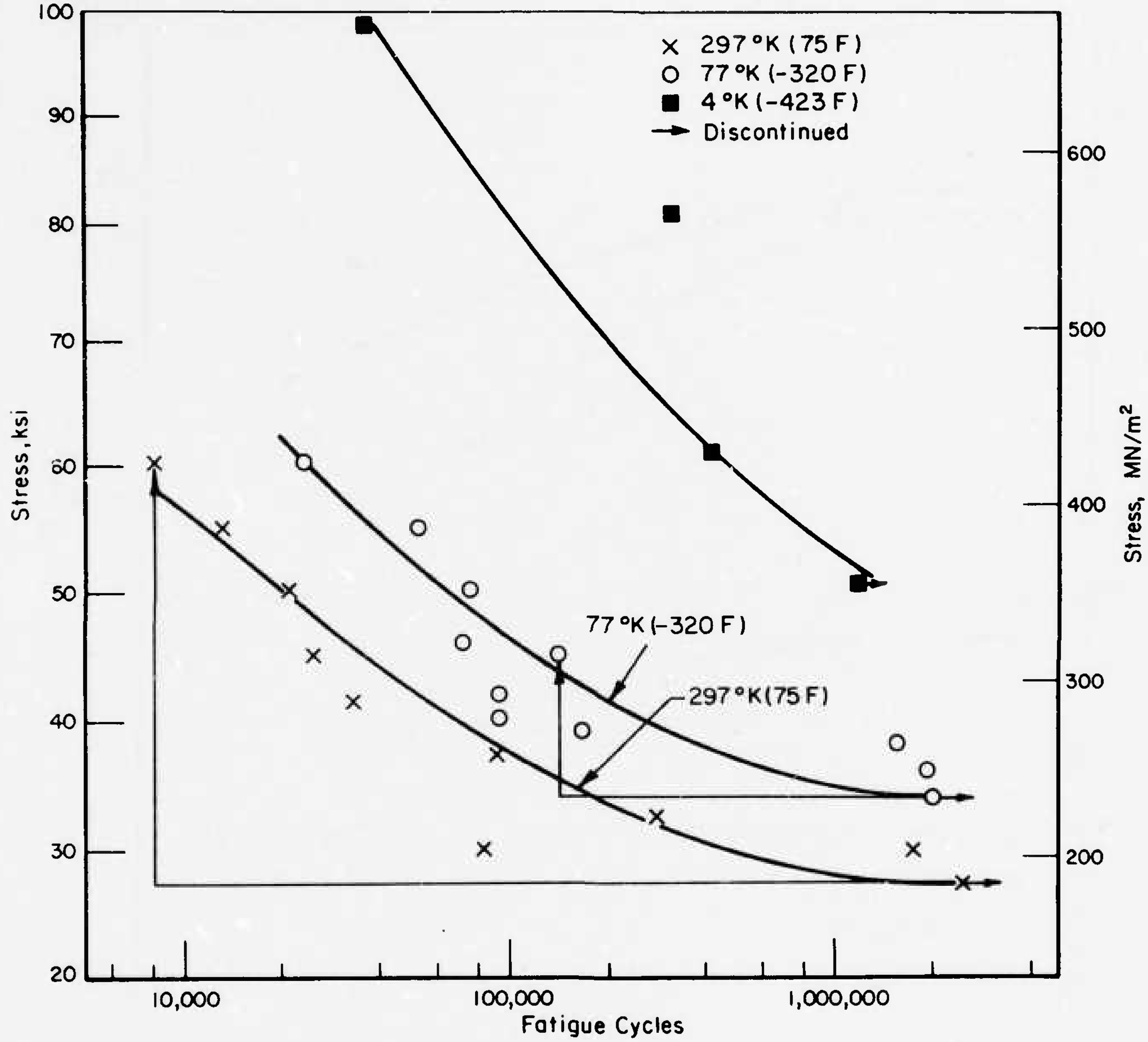
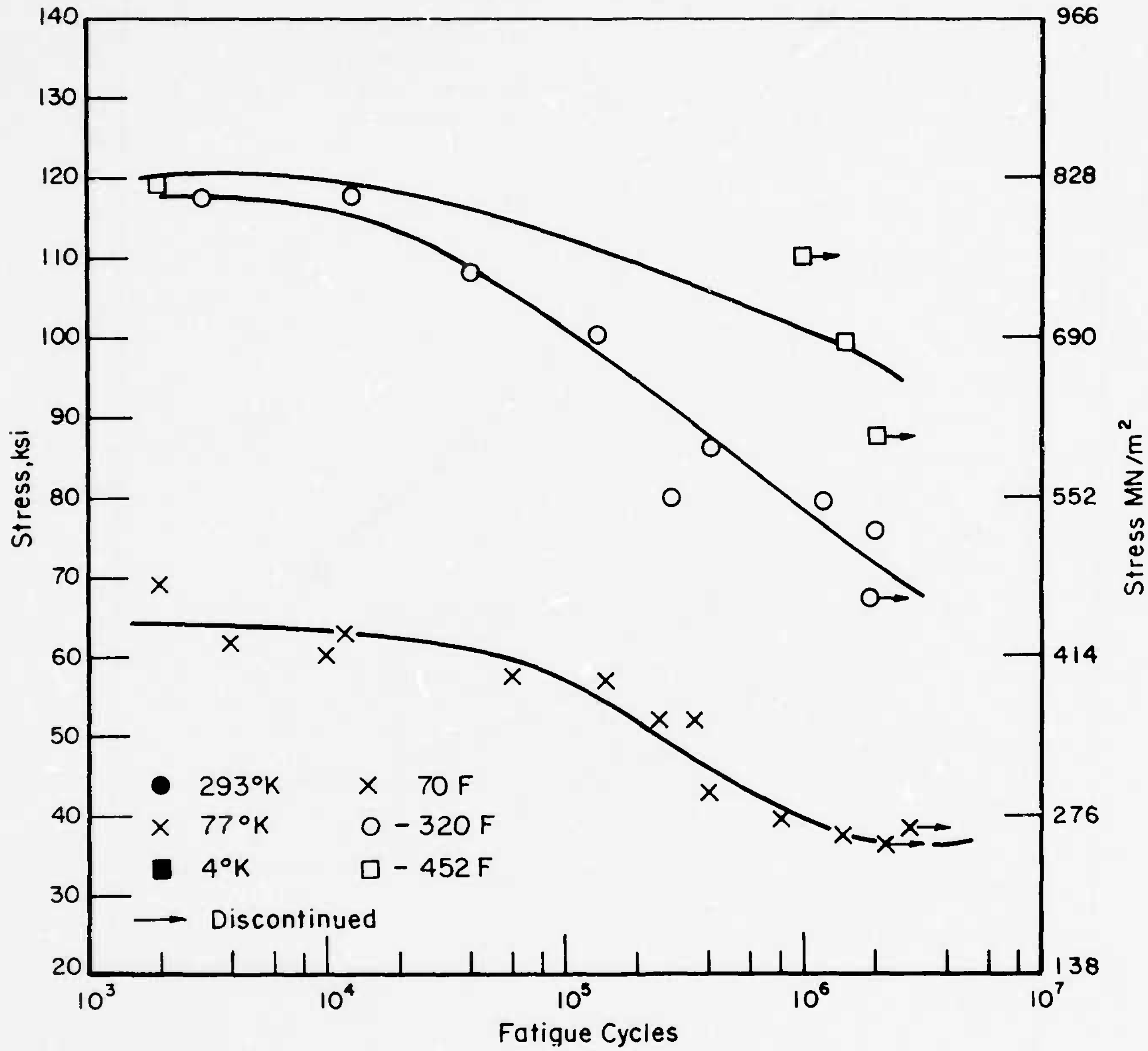


FIGURE 8.1.4-ME2. AXIAL FATIGUE LIFE CURVES FOR NOTCHED 310 STAINLESS STEEL BAR [Up to 2.540 cm (1.000 in.) diameter] [94208A, 95168]



140
130
120
110
100
90
80
70
60
50
40
30
20
Stress, ksi
966
828
690
552
414
276
138
Stress MN/m²
293°K
77°K
4°K
70 F
- 320 F
- 452 F
Discontinued
10³
10⁴
10⁵
10⁶
10⁷
Fatigue Cycles

8.1.4-6.2 (11/76)

TABLE 8.1.5-ME1

Alloy Designation: Type 316 Stainless Steel

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	596 (86.4)			1576 (229)		
	Min	592 (85.9)			1510 (219)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	275 (39.8)			666 (96.6)		
	Min	273 (39.6)			660 (95.8)		
Std. Deviation							
Elong, percent	Avg	60.5			55.3		
	Min	60			48		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 33262

TABLE 8.1.5-ME1.1

Alloy Designation: Type 316 Stainless Steel (Weld Metal)

Specification:
Form: Sheet-TIG welded, Type 347 filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed sheet welded and tested as welded

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	554 (80.4)				1314 (190.6)	
	Min	533 (77.3)				1225 (177.7)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 33262

TABLE 8.1.5-ME2

Alloy Designation: Type 316 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)		170 (-154)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	579 (84.0)		869 (126)	1227 (178)		1461 (212)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	76		81	64		54
	Min						
RA, percent	Avg	73.5		74.5	68.0		55.0
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	696 (101)		1020 (148)	1400 (203)		1558 (226)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.5-ME3

Alloy Designation: Type 316 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	233	(-40)	195	(-108)	153	(-184)	77	(-320)	10	(-442)
Compression, Longitudinal													
CYS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Ec, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Compression, Transverse													
CYS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Ec, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Shear[a]													
SUS, MN/m^2 (ksi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
G, GN/m^2 (10^6 psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Impact, Charpy V, Testing Temp.													
Long., J(ft-lb)	Avg	192	(142)	210	(155)	168	(124)	146	(108)	146	(108)	132	(97)
	Min												
No. of Spec. (No. of Heats)													
Trans., J(ft-lb)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Fracture Toughness[b]													
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg												
	Min												
Orientation: —													
No. of Spec. (No. of Heats)													
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg												
(From PTSC spec.)(—)	Min												
No. of Spec. (No. of Heats)													

References: 52856

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

TABLE 8.1.5-ME3.1

Alloy Designation:	Type 316 Stainless Steel (Weld Metal)
Specification:	
Form:	Plate-MIG welded, type 316 covered electrode
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate welded, annealed 1366 K (2000 F) 1 hr, WQ, tested as quenched

Testing Temperature, K (F)		297 (75)	168 (-156)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	553 (80.2)	855.0 (124.0)		1176 (170.5)		1382 (200.5)
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	55.0	60.0		53.0		50.0
	Min						
RA, percent	Avg	60.0	51.5		54.0		43.0
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	699.8 (101.5)	868.7 (126.0)		1127 (163.5)		1351 (196.0)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.5-ME4

Alloy Designation: Type 316 Stainless Steel

Specification:
Form: Bar
Diameter: Up to 2.540 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	647 (93.9)	910 (132)	1110 (161)	1269 (184)		1489 (216)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	47	59	60	59		52
	Min						
RA, percent	Avg	37.5	38.0	77.7	76.2		59.7
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		(1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 45464

TABLE 8.1.6-ME2.1

Alloy Designation: Type 321 Stainless Steel (Weld Metal)

Specification:
Form: Sheet-TIG welded, filler not specified
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed sheet welded and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	598 (86.7)			1413 (205.0)	893.6 (129.6)	
	Min	597 (86.6)			1367 (198.3)	792.9 (115.0)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61996

60

TABLE 8.1.6-ME3

Alloy Designation: Type 321 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	560 (81.2)			1494 (217)		
	Min	543 (78.7)			1453 (211)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	236 (34.3)			393 (57.0)		
	Min	205 (29.8)			386 (56.0)		
Std. Deviation							
Elong, percent	Avg	58.2			30.4		
	Min	57.5			28.2		
RA, percent	Avg	65.4			51.6		
	Min	63.8			51.3		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	581 (84.3)			733 (106)		
K_t = 6.3	Min	579 (84.0)			696 (101)		
No. of Spec. (No. of Heats)		3 (1)			2 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66080

TABLE 8.1.6-ME4

Alloy Designation: Type 321 Stainless Steel

Specification:	
Form:	Bar
Diameter:	Up to 2.54 cm (1.000 in.)
Condition:	Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	**673**	**(97.6)**	**1054**	**(153)**	**1537**	**(223)**	**1862**	**(270)**		
	Min	670	(97.2)	1043	(151)	1516	(220)	1844	(267)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	**429**	**(62.2)**	**385**	**(55.9)**	**451**	**(65.4)**	**403**	**(58.5)**		
	Min	425	(61.6)	371	(53.8)	445	(64.6)	402	(58.3)		
Std. Deviation											
Elong, percent	Avg	**55.1**		**45.7**		**37.9**		**34.7**			
	Min	54.5		44.6		37.1					
RA, percent	Avg	**79.4**		**72.7**		**60.0**		**43.6**			
	Min	78.4		71.8		53.3					
No. of Spec. (No. of Heats)		2	(1)	3	(1)	4	(1)	2	(1)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg										
	Min										
Std. Deviation											
Elong, percent	Avg										
	Min										
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)											
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 54986

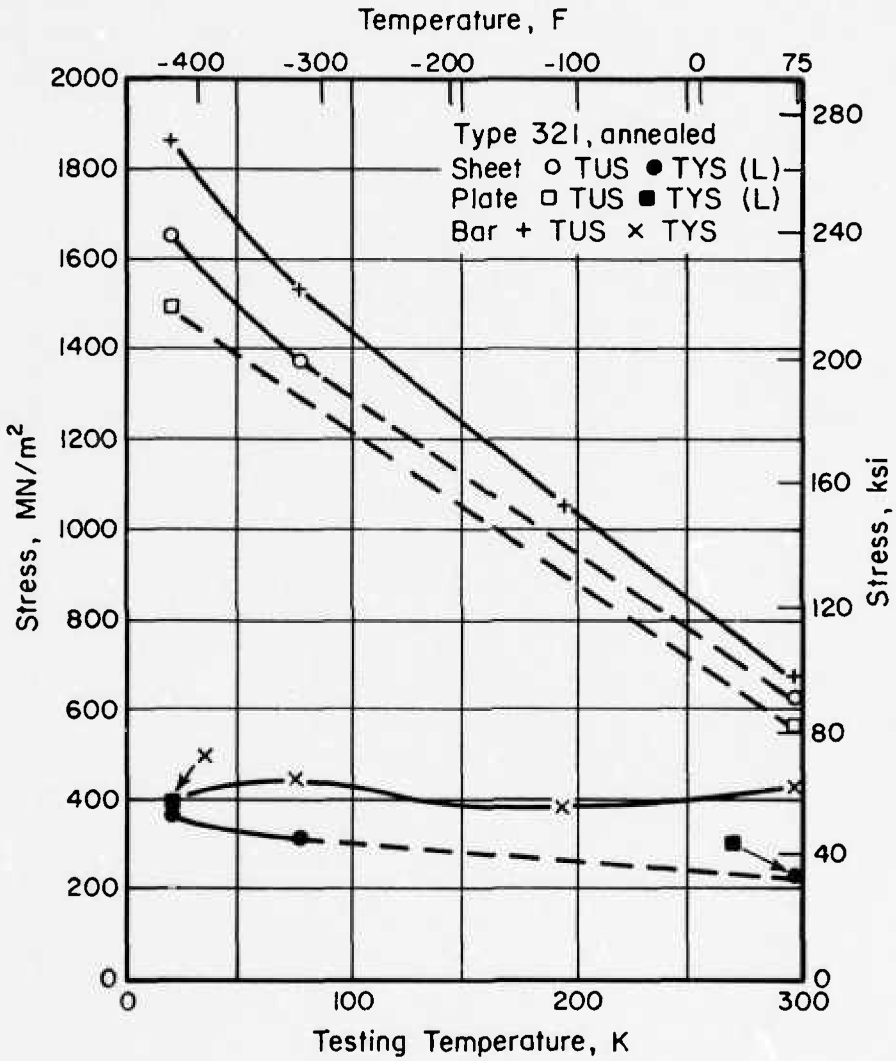


FIGURE 8.1.6-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 321 STAINLESS STEEL

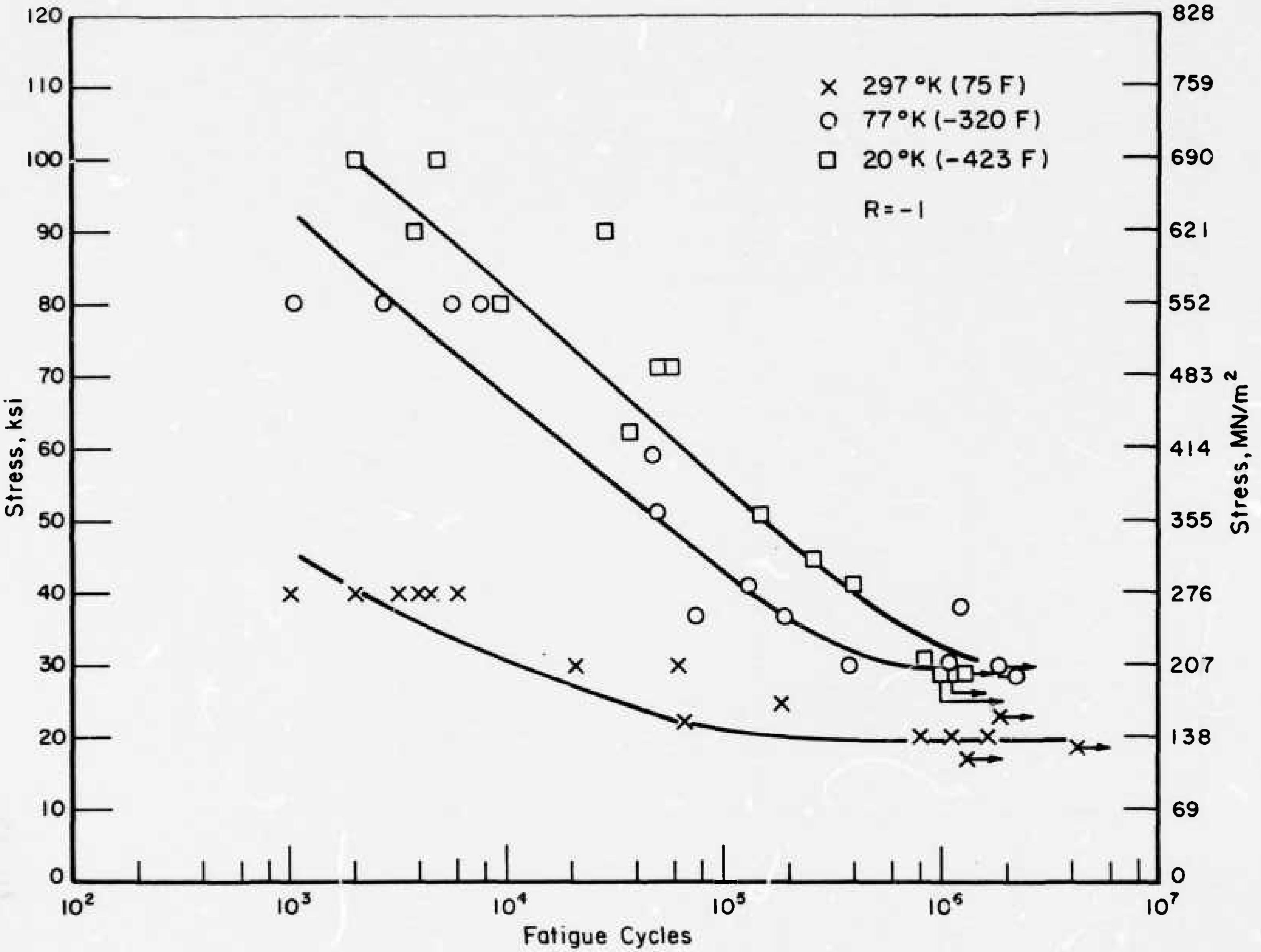


FIGURE 8.1.6-ME2. AXIAL FATIGUE LIFE CURVES FOR 321 (ANNEALED) STAINLESS STEEL ALLOY SHEET 0.230 cm (0.090 in.) THICK, AS WELDED [TIG welded; filler not specified] [61996]

TABLE 8.1.6-TR1

Alloy Designation: Type 321 Stainless Steel

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.232	-0.267	-0.268	-0.269	-0.269
No. of Spec.	2	2	2	2	1	1
References: 48134, 69332						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	74.0×10^{-8}	57.5×10^{-8}	53.5×10^{-8}	53.0×10^{-8}	53.0×10^{-8}	53.0×10^{-8}
Ohm circular mil ft^{-1}	(445)	(346)	(322)	(319)	(319)	(319)
No. of Spec.	1	1	1	1	1	1
References: 79561						

TABLE 8.1.7-TR1

Alloy Designation: Type 303 Stainless Steel

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.233	-0.263	-0.267		
No. of Spec.	1	1	1	1		
References: 48134						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	71.2×10^{-8}	53.7×10^{-8}	50×10^{-8}	50×10^{-8}	50×10^{-8}	50×10^{-8}
Ohm circular mil ft^{-1}	(428)	(323)	(301)	(301)	(301)	(301)
No. of Spec.	2	2	2	2	2	2
References: 79561, 90318						

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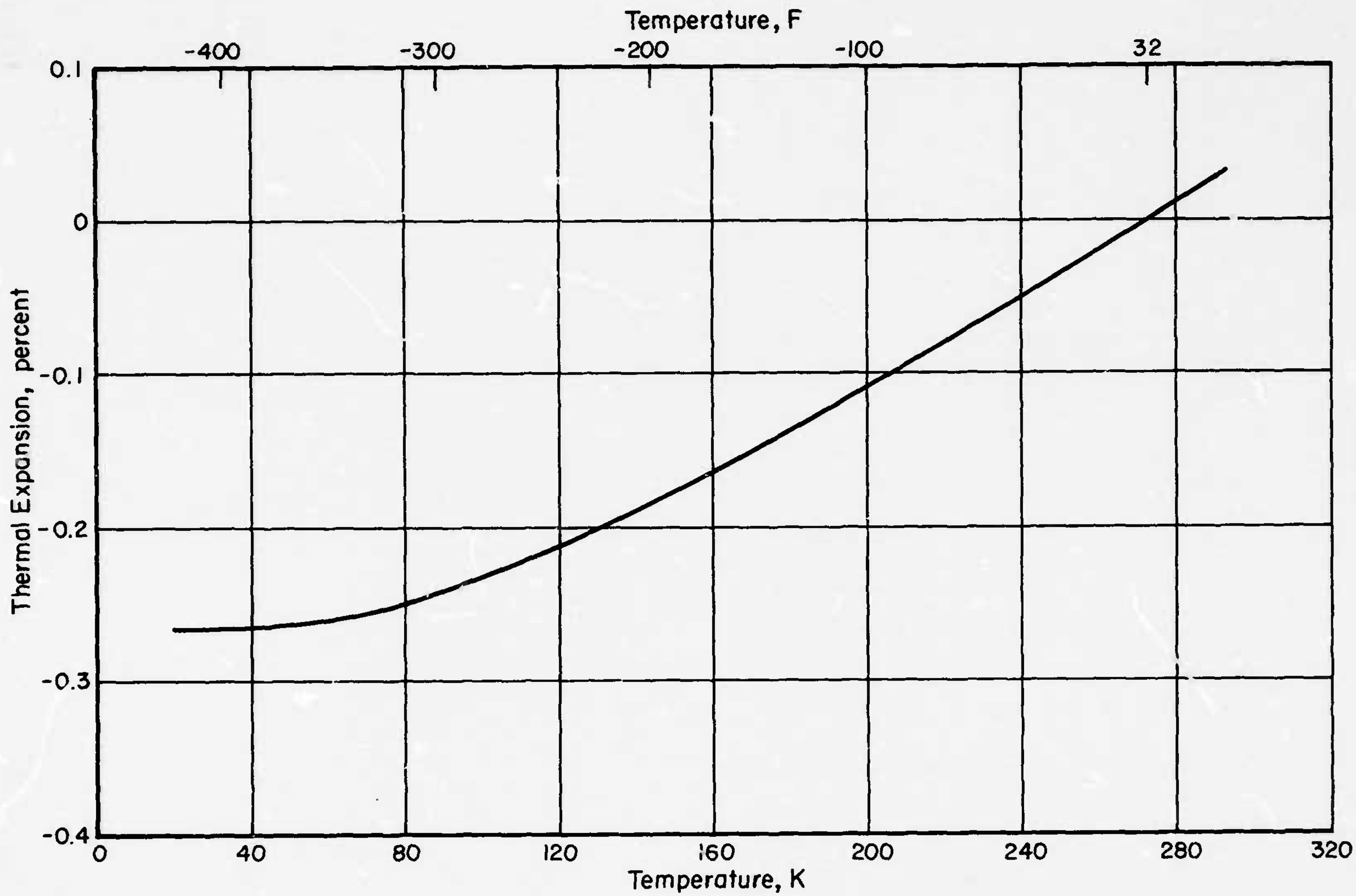

FIGURE 8.1.7-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 303 STAINLESS STEEL

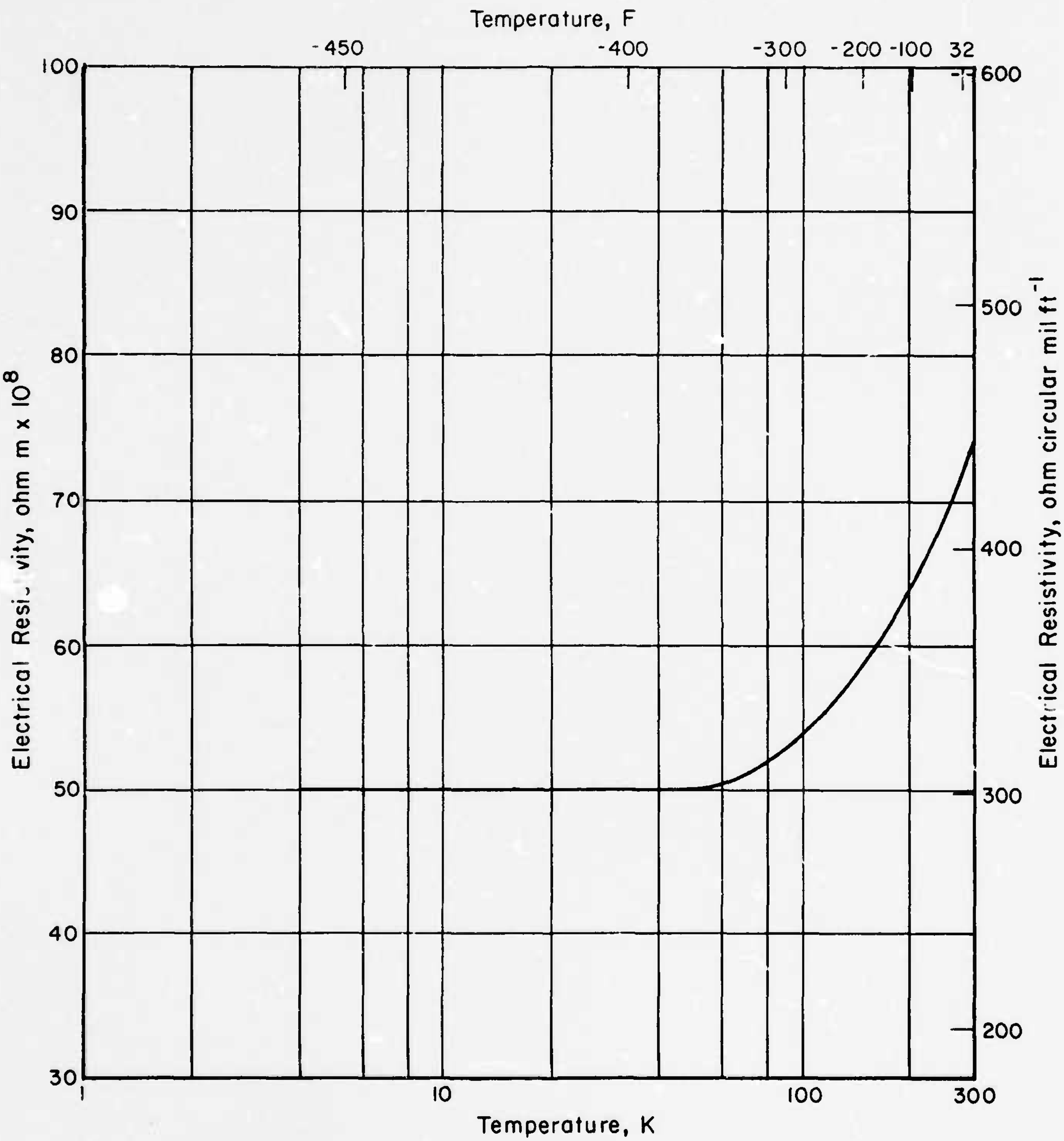

FIGURE 8.1.7-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 303 STAINLESS STEEL

TABLE 8.1.8-ME0.1

Alloy Designation:	Type 310S Stainless Steel	S31008
Specification:		
Form:	Sheet	
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)	
Condition:	Annealed	

Testing Temperature, K (F)		297 (75)				4 (-452)
Tension, Longitudinal						
TUS, MN/m^2 (ksi)	Avg					1230 (178)
	Min					1140 (165)
Std. Deviation						
TYS, MN/m^2 (ksi)	Avg					772 (112)
	Min					738 (107)
Std. Deviation						
Elong, percent	Avg					59
	Min					54
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						4 (1)
E, GN/m^2 (10^6 psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m^2 (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m^2 (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m^2 (ksi)	Avg					1280 (186)
	Min					1260 (183)
Std. Deviation						
TYS, MN/m^2 (ksi)	Avg					800 (116)
	Min					772 (112)
Std. Deviation						
Elong, percent	Avg					58
	Min					56
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						3 (1)
E, GN/m^2 (10^6 psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m^2 (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m^2 (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						

References: 77930

TABLE 8.1.8-ME1

Alloy Designation:	Type 310S Stainless Steel	S31008
Specification:		
Form:	Forging	
Thickness, cm (in.):	Up to 2.540 (1.000)	
Condition:	Solution Treated 1365 K (2000 F) 1 hr., WQ	(STQ)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	585 (84.8)	1098 (159.2)	1303 (189.0)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	261 (37.9)	604 (87.6)	817 (118.5)			
	Min						
Std. Deviation							
Elong, percent	Avg	53.8	71.8	64.3			
	Min						
RA, percent	Avg	70.7	51.6	44.6			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	798 (115.8)	1355 (196.5)	1598 (231.8)			
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

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TABLE 8.1.8-ME2

Alloy Designation:	Type 310S Stainless Steel	S31008
Specification:		
Form:	Forging	
Thickness, cm (in.):	Up to 2.540 (1.000)	
Condition:	Solution Treated 1365 K (2000 F) 1 hr., FC to 700 K (800 F) 30 min., AC	(STFC)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	578 (83.8)	1034 (150.0)	1300 (188.5)			
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	226 (32.8)	574 (83.2)	817 (118.5)			
	Min						
Std. Deviation							
Elong, percent	Avg	57.2	48.6	61.0			
	Min						
RA, percent	Avg	62.2	31.2	43.6			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	763 (110.6)	1198 (173.8)	1472 (213.5)			
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

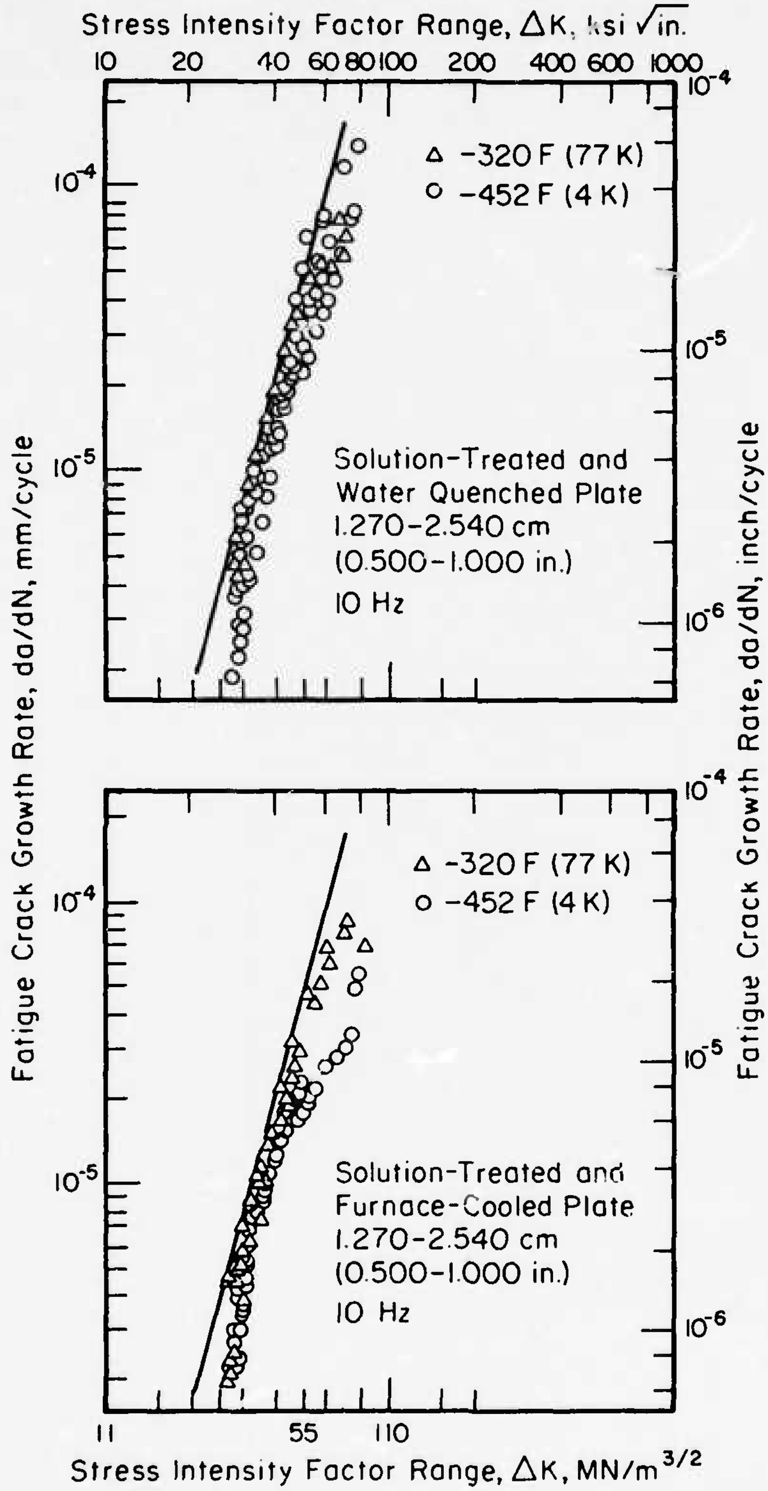

FIGURE 8.1.8-ME1. FATIGUE CARCK GROWTH RATE PROPERTIES OF AISI 310S STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94208G)

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TABLE 8.1.8 TR1

Alloy Designation: Type 310S Stainless Steel S31008

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	12.4	8.10	5.35	2.30	1.15	
Btu hr^{-1} ft^{-1} F^{-1}	(7.17)	(4.68)	(3.09)	(1.33)	(0.665)	
No. of Spec.	1	1	1	1	1	
References: 94206						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}	480	255	105*	12.1	5.36	2.24
Btu lb^{-1} F^{-1}	(0.115)	(6.09×10^{-2})	(2.51×10^{-2})*	(2.89×10^{-3})	(1.28×10^{-3})	(5.35×10^{-4})
No. of Spec.	2	2	0	2	2	2
References: 90202, 94208, 95168						
Electrical Resistivity						
Ohm m	90×10^{-8}	78×10^{-8}	74×10^{-8}	71×10^{-8}	70×10^{-8}	70×10^{-8}
Ohm circular mil ft^{-1}	(541)	(469)	(445)	(427)	(421)	(421)
No. of Spec.	2	2	2	2	2	2
References: 94260, 94208						

* Extrapolated

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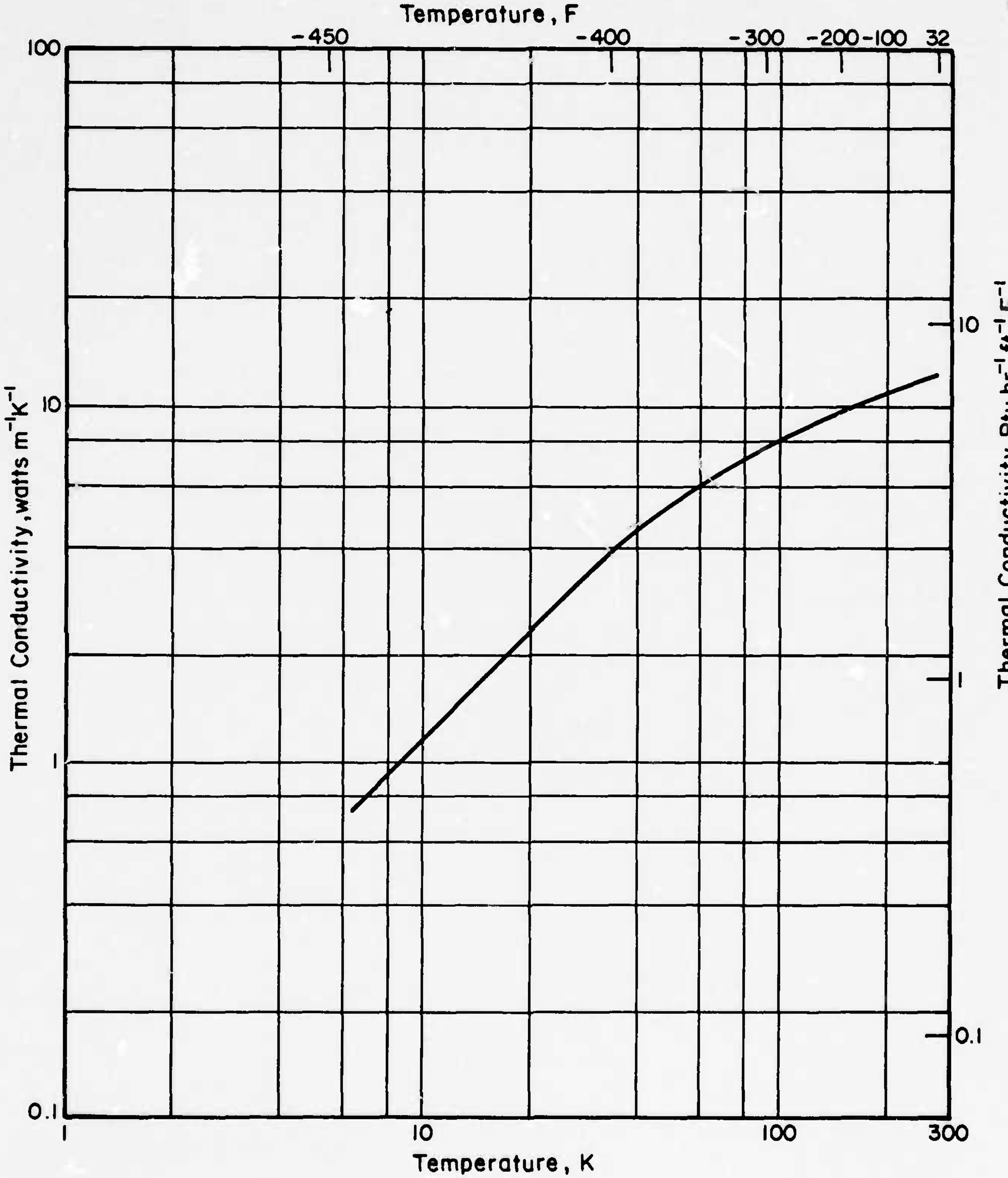

FIGURE 8.1.8-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 310 STAINLESS STEEL

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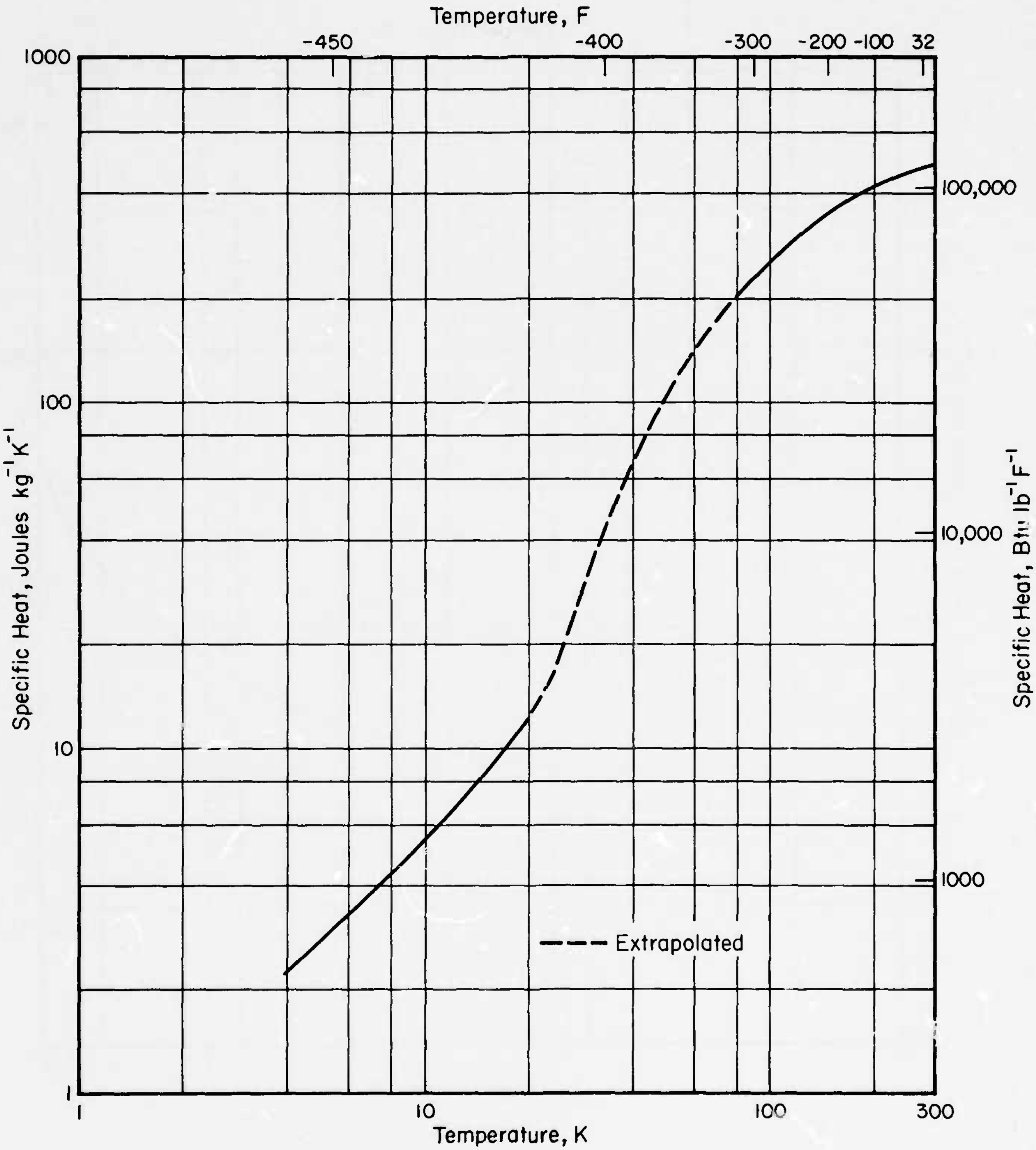

FIGURE 8.1.8-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR TYPE 310S STAINLESS STEEL

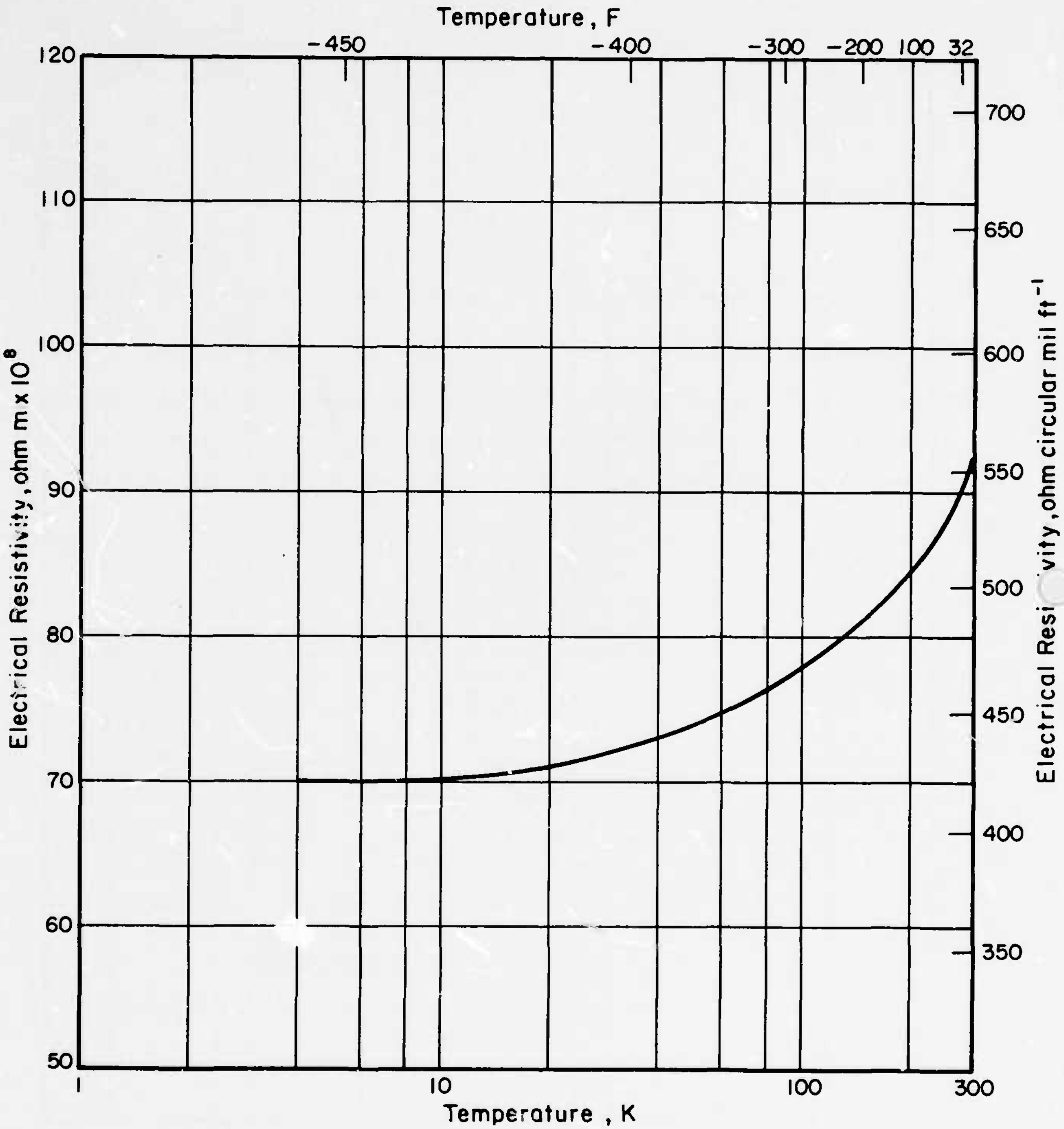

FIGURE 8.1.8-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 310S STAINLESS STEEL

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TABLE 8.1.9-ME7

Alloy Designation:		Type 347 Stainless Steel		S34700			
Specification:							
Form:		Plate					
Thickness, cm (in.):		1.270 to 2.540 (0.500 to 1.000)					
Condition:		Annealed 2000 F 1 hr., WQ		Average grain diameter 0.013mm			

Testing Temperature, K (F)		297 (75)	168 (-76)	77 (-320)	4 (-452)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	594 (86.2)	982 (142.5)	1322 (191.7)	1560 (232.0)		
	Min	554 (80.4)	962 (139.6)	1296 (188.0)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg		465 (67.4)	493 (71.6)			
	Min						
Std. Deviation							
Elong, percent	Avg	58.5	50.0	43.0	41.0		
	Min	57.0	47.0	38.0			
RA, percent	Avg	68.4	61.9	46.8	49.0		
	Min	66.3	58.8	34.6			
No. of Spec. (No. of Heats)		2 (2)	2 (2)	2 (2)	1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	724 (105.0)	1114 (161.5)	1200 (174.0)	1351 (196.0)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1	1	1		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856, 96683

TABLE 8.1.9-ME7.1

Alloy Designation: Type 347 Stainless Steel S34700

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Commercially treated, softed, descaled

Testing Temperature, K (F)		297 (75)	223 (-58)	173 (-148)	148 (-193)	123 (-240)	77 (-320)
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	120 (87)	140 (105)	140 (105)	120 (92)	120 (91)	110 (83)
	Min	110 (83)	130 (99)				110 (80)
No. of Spec. (No. of Heats)		2 (1)	2 (1)	1	1	1	3 (1)
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation –							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 96683

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

6[illegible]

TABLE 8.1.9-ME7.2

Alloy Designation:	Type 347 Stainless Steel (Weld Metal)	S34700
Specification:		
Form:	Plate-MIG welded, type 347 covered electrode	
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)	
Condition:	Plate welded, annnealed 1366 K (2000 F) 1 hr, WQ, tested as quenched	

Testing Temperature, K (F)		297 (75)	168 (-156)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	634 (92.0)	1034 (150.0)		1358 (197.0)		1505(227.0)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	59.0	62.0		48.0		41.0
	Min						
RA, percent	Avg	68.5	66.5		60.5		41.0
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	761.9 (110.5)	899.7 (130.5)		1045 (151.5)		1200(174.0)
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.9-ME8

Alloy Designation:	Type 347 Stainless Steel	S34700
Specification:		
Form:	Plate	
Thickness, cm (in.):	over 5.080 (2.000)	
Condition:	Annealed	

Testing Temperature, K (F)		297 (75)	90 (-300)	20 (-423)			
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg		104 (77)	80.0 (59)			
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg		78.6 (58)	71.9 (53)			
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 94205

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

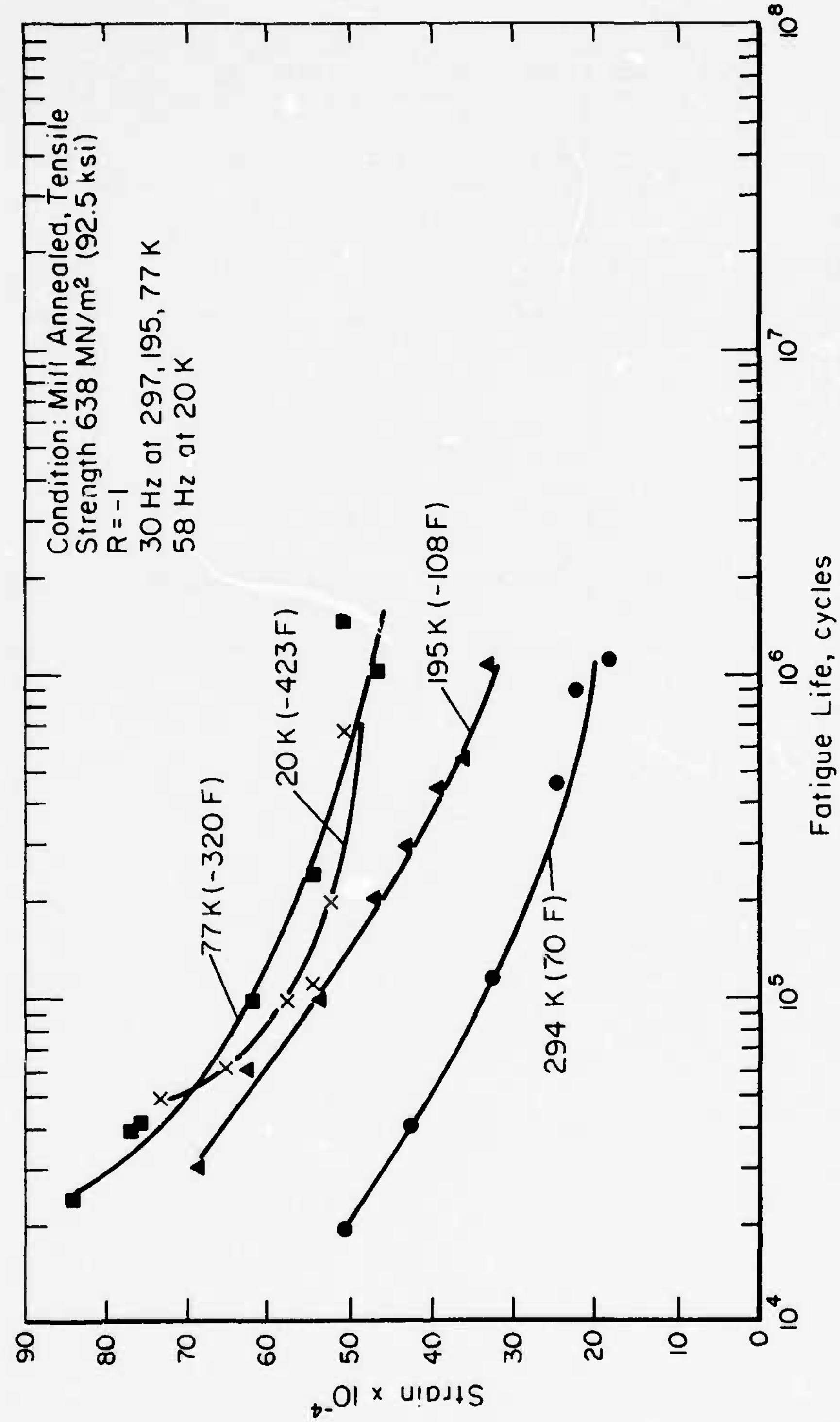

FIGURE 8.1.9-ME1. UNNOTCHED (K_T = 1) FLEXURE FATIGUE BEHAVIOR OF ANNEALED 347 STAINLESS STEEL SHEET (Up to 0.099cm [0.039 in.])49048

TABLE 8.1.9-TR1

Alloy Designation: Type 347 Stainless Steel S34700

Specification:
Form:
Dimension.
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1} (1)	13.6	9.04	5.65	2.18	0.926	
Btu hr^{-1} ft^{-1} F^{-1}	(7.86)	(5.23)	(3.27)	(1.26)	(0.535)	
No. of Spec.	1	1	1	1	1	
References: 90193						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.234	-0.266	-0.267	-0.267	-0.267
No. of Spec.	1	1	1	1	1	1
References: 69332						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m (1)	74.4×10^{-8}	58.6×10^{-8}	54.7×10^{-8}	54.4×10^{-8}	54.4×10^{-8}	
Ohm circular mil ft^{-1}	(448)	(352)	(329)	(327)	(327)	
Ohm m (2)	70.8×10^{-8}	54.0×10^{-8}	50.2×10^{-8}	50.0×10^{-8}	50.1×10^{-8}	50.1×10^{-8}
Ohm circular mil ft^{-1}	(426)	(325)	(302)	(301)	(301)	(301)
No. of Spec.	2	2	2	2	2	2
References: 79561, 90193						

(1) Triple brazed condition.
(2) Annealed.

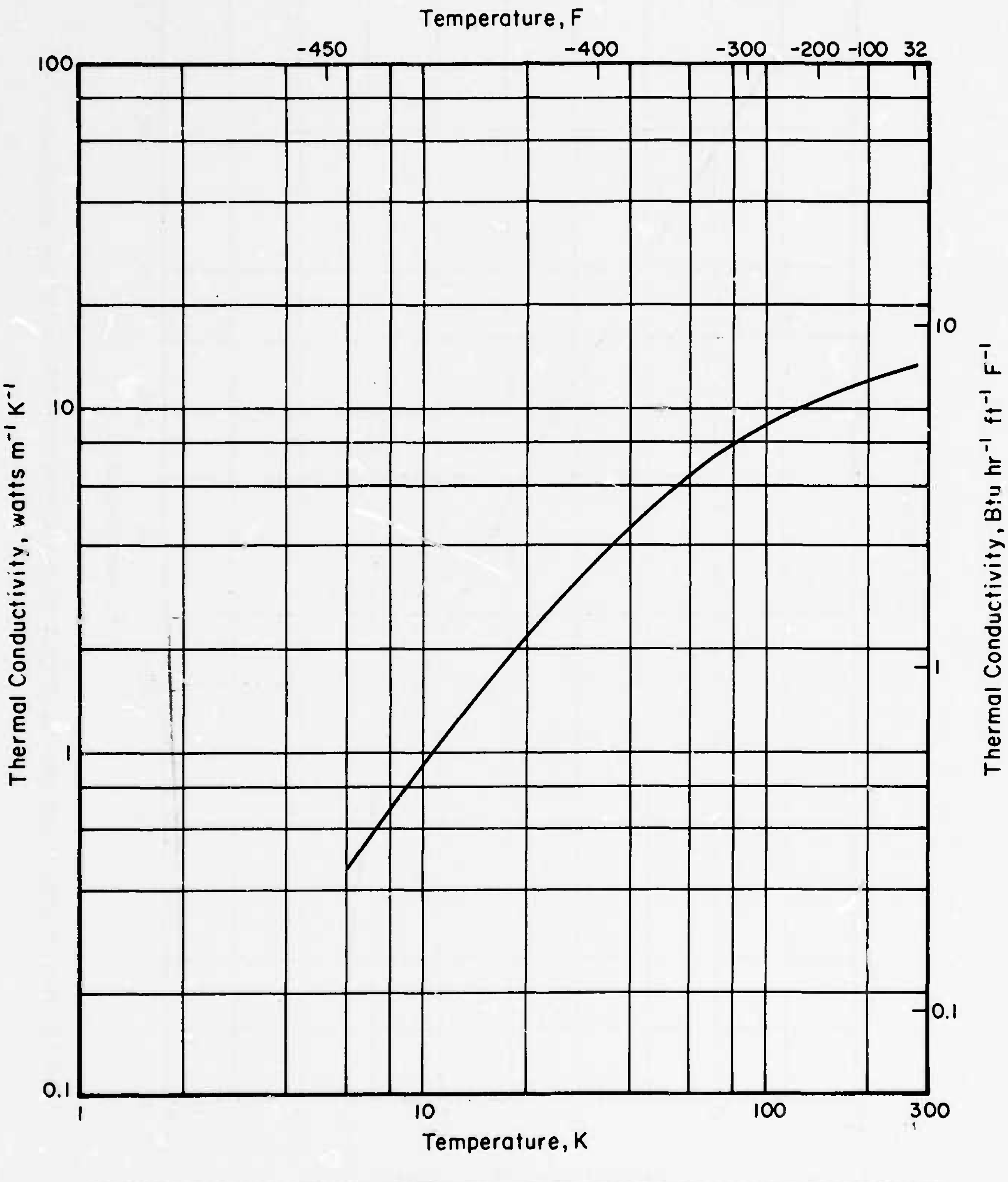

FIGURE 8.1.9-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 347 STAINLESS STEEL (Triple Brazed Condition)

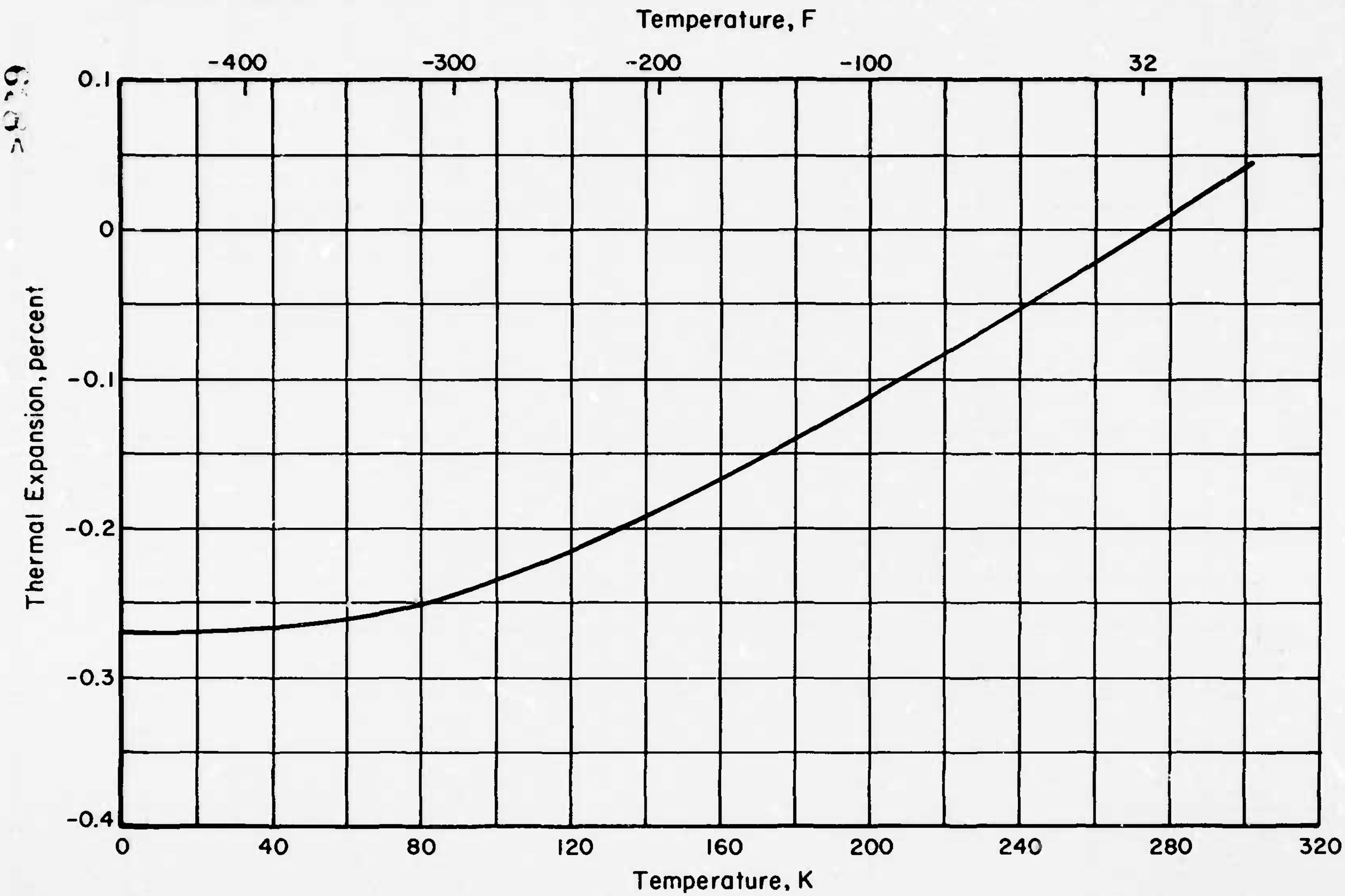

FIGURE 8.1.9-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 347 STAINLESS STEEL

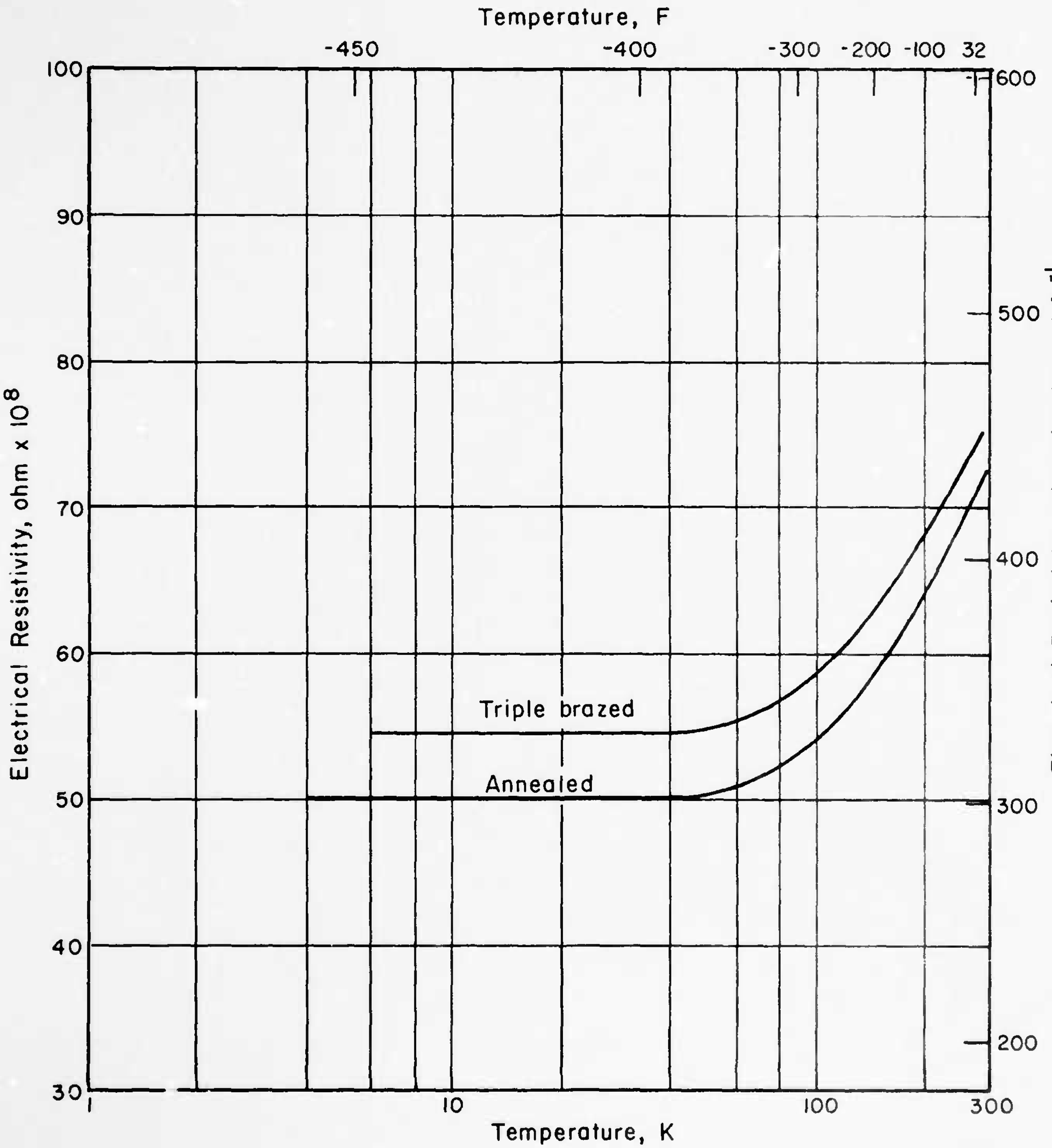

FIGURE 8.1.9-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 347 STAINLESS STEEL

TABLE 8.1.10-ME1

Alloy Designation: Type 410 Stainless Steel

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Heat treated 1255 K (1800 F) 1 hr, OQ, tempered 644 K (700 F) 4 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1383 (200.6)	1463 (212.2)		1821 (264.1)	2213 (321.8)	
	Min	1342 (194.7)	1419 (205.8)		1785 (258.9)	2178 (315.9)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1383 (200.6)	1463 (212.2)		1821 (264.1)		
	Min	1342 (194.7)	1419 (205.8)		1785 (258.9)		
Std. Deviation							
Elong, percent	Avg	14.3	15.1		5.8	0.8	
	Min	13.9	13.8		5.4	0.7	
RA, percent	Avg	67.2	64.4		20.6	5.6	
	Min	66.2	63.2		20.6	5.2	
No. of Spec. (No. of Heats)		3 (1)	3 (1)		2 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 54986

TABLE 8.1.10-ME2

Alloy Designation: Type 410 Stainless Steel

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Heat treated 1255 K (1800 F) 1 hr, OQ, tempered 644 K (700 F) 4 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	30.4 (22.5)	12.8 (9.5)		3.4 (2.5)		
	Min	22.3 (16.5)	8.1 (6.0)		2.7 (2.0)		
No. of Spec. (No. of Heats)		7 (1)	8 (1)		5 (1)		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 54986

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 8.1.10-TR1

loy Designation: Type 410 Stainless Steel

ecification:
orm:
imension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	27.2	21.1	13.1			
Btu hr^{-1} ft^{-1} F^{-1}	(15.7)	(12.3)	(7.57)			
No. of Spec.	1	1	1			
References: 90224						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.144	-0.155	-0.156	-0.156	-0.156
No. of Spec.	2	2	2	2	2	2
References: 48571, 90226						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity(1)						
Ohm m	5.50×10^{-7}	4.12×10^{-7}	3.86×10^{-7}	3.82×10^{-7}	3.82×10^{-7}	3.82×10^{-7}
Ohm circular mil ft^{-1}	(336)	(248)	(232)	(230)	(230)	(230)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) Hardened.

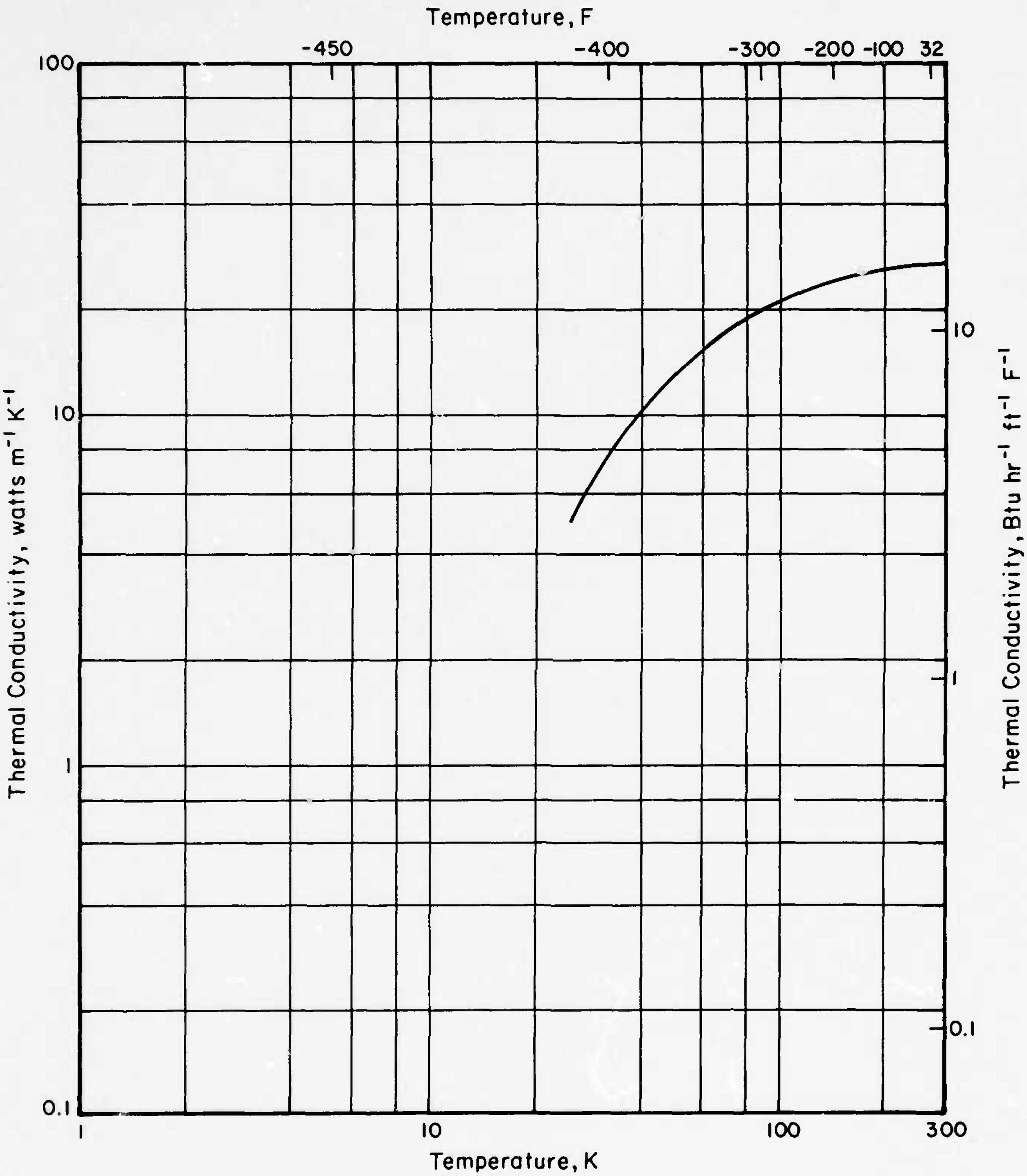

FIGURE 8.1.10-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 410 STAINLESS STEEL

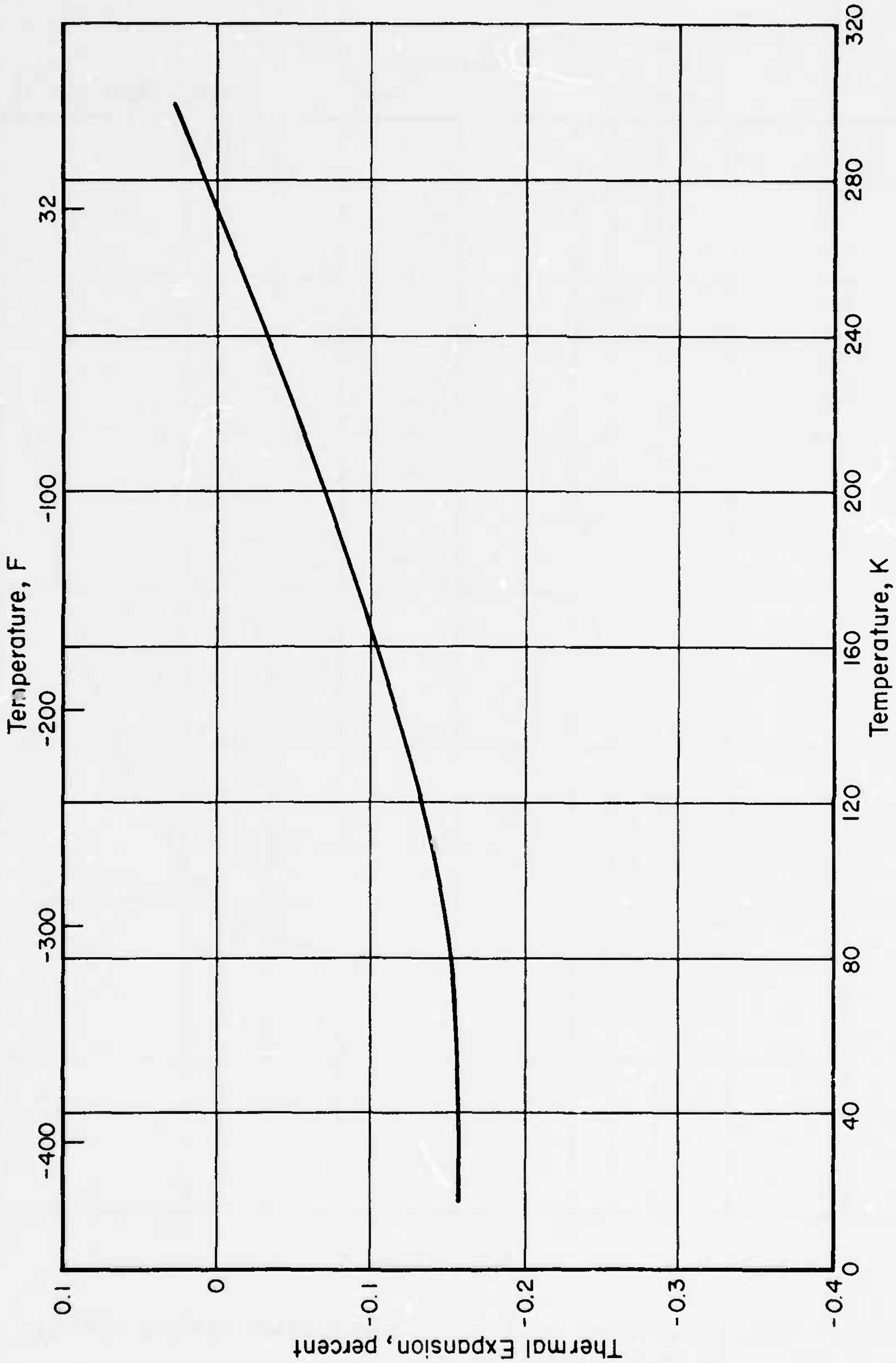

FIGURE 8.1.10-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 410 STAINLESS STEEL

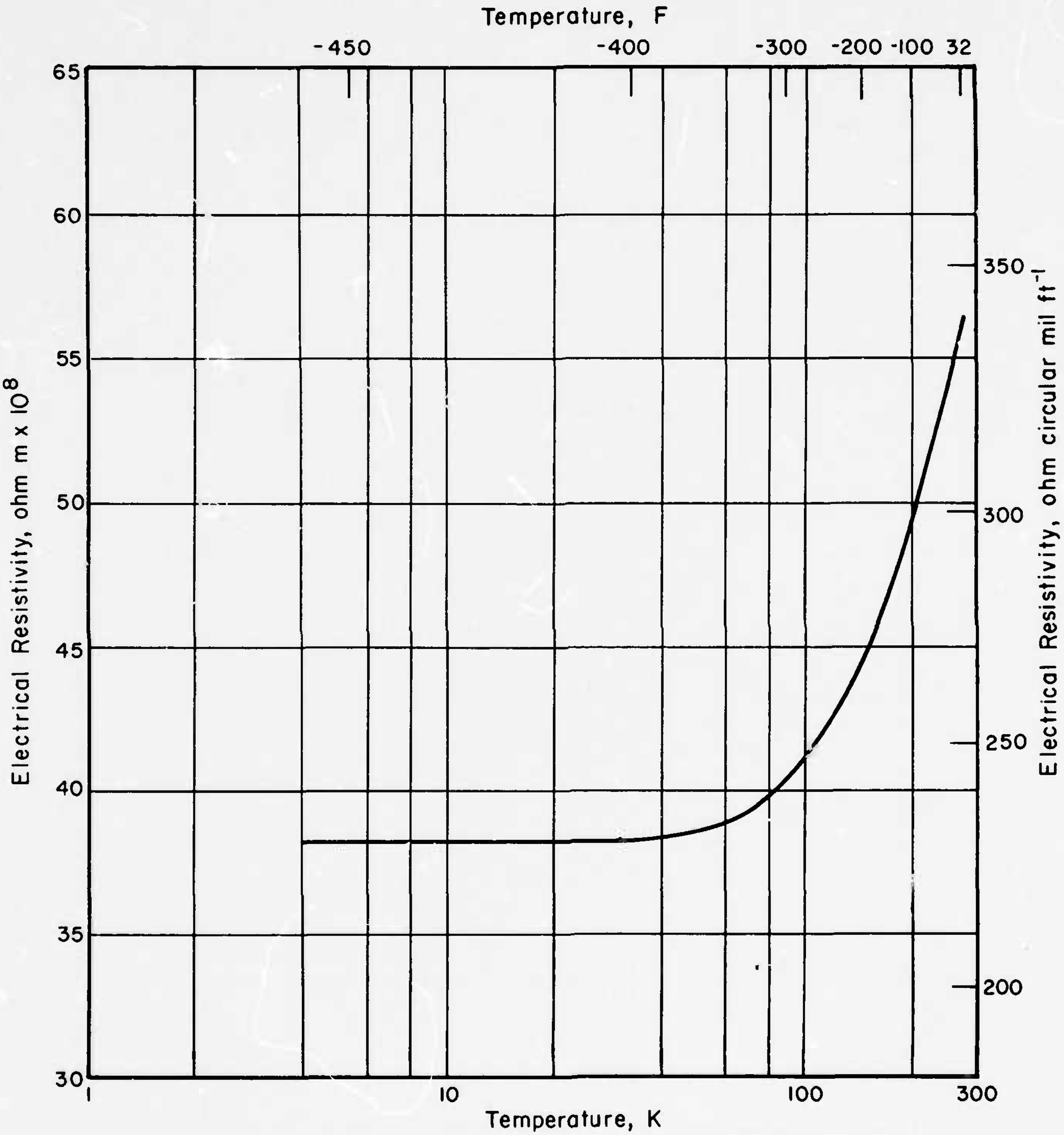

FIGURE 8.1.10-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 410 STAINLESS STEEL

TABLE 8.1.11-ME1

Alloy Designation: Type 416 Stainless Steel

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Heat treated 1255 K (1800 F) 1 hr, OQ, tempered 644 K (700 F) 4 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1400 (203.1)	1504 (218.1)		1800 (261.1)	2017 (292.6)	
	Min	1388 (201.3)	1498 (217.3)		1781 (258.3)	2000 (290.1)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1200 (174.1)	1259 (182.6)		1598 (231.8)	2017 (292.6)	
	Min	1142 (165.6)	1257 (182.3)		1587 (230.2)	2000 (290.1)	
Std. Deviation							
Elong, percent	Avg	15.1	15.4		9.2	0.4	
	Min	14.9	15.3		8.2		
RA, percent	Avg	53.3	52.0		23.5	2.3	
	Min	52.2	51.6		18.2	2.1	
No. of Spec. (No. of Heats)		3 (1)	2 (1)		4 (1)	2 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 54986

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TABLE 8.1.11-M.2

Alloy Designation: Type 416 Stainless Steel

Specification:
Form:
Thickness, cm (in.):
Condition:

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[(a)]							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	45.4 (33.6)	13.5 (10.0)		3.4 (2.5)		
	Min	45.2 (33.5)	12.8 (9.5)		2.7 (2.0)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)		5 (1)		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[(b)]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 54986

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 8.1.11-TR1

Alloy Designation: Type 416 Stainless Steel

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T)(1) Longitudinal						
Percent	0	-0.148	-0.164	-0.167		
No. of Spec.	1	1	1	1		
References: 48134						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity (2)						
Ohm m	6.62×10^{-7}	5.46×10^{-7}	5.27×10^{-7}	5.23×10^{-7}	5.23×10^{-7}	5.23×10^{-7}
Ohm circular mil ft^{-1}	(398)	(328)	(317)	(315)	(315)	(315)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) Hot-rolled.
(2) Hardened.

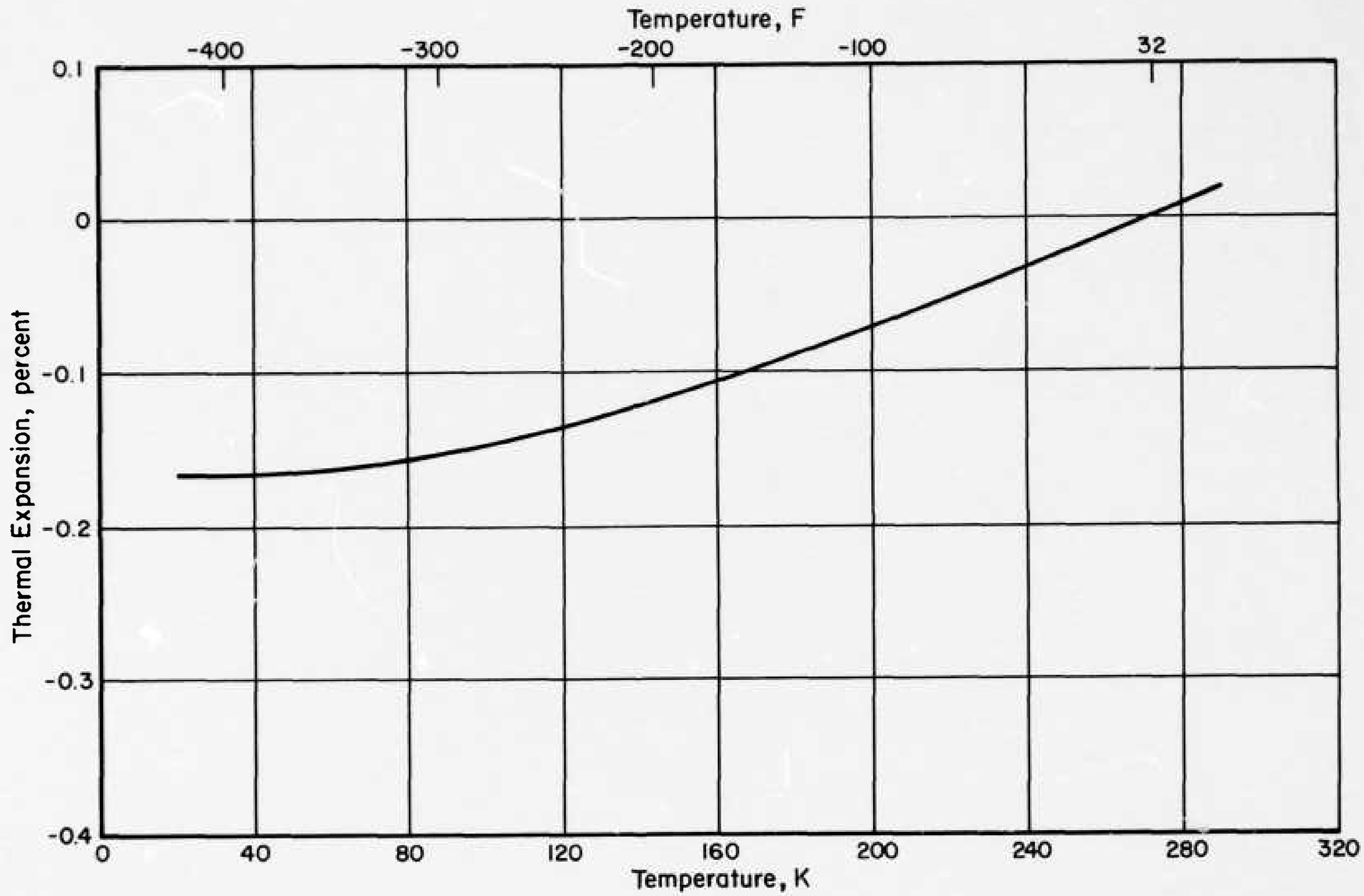

FIGURE 8.1.11-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 416 STAINLESS STEEL (Hot-rolled)

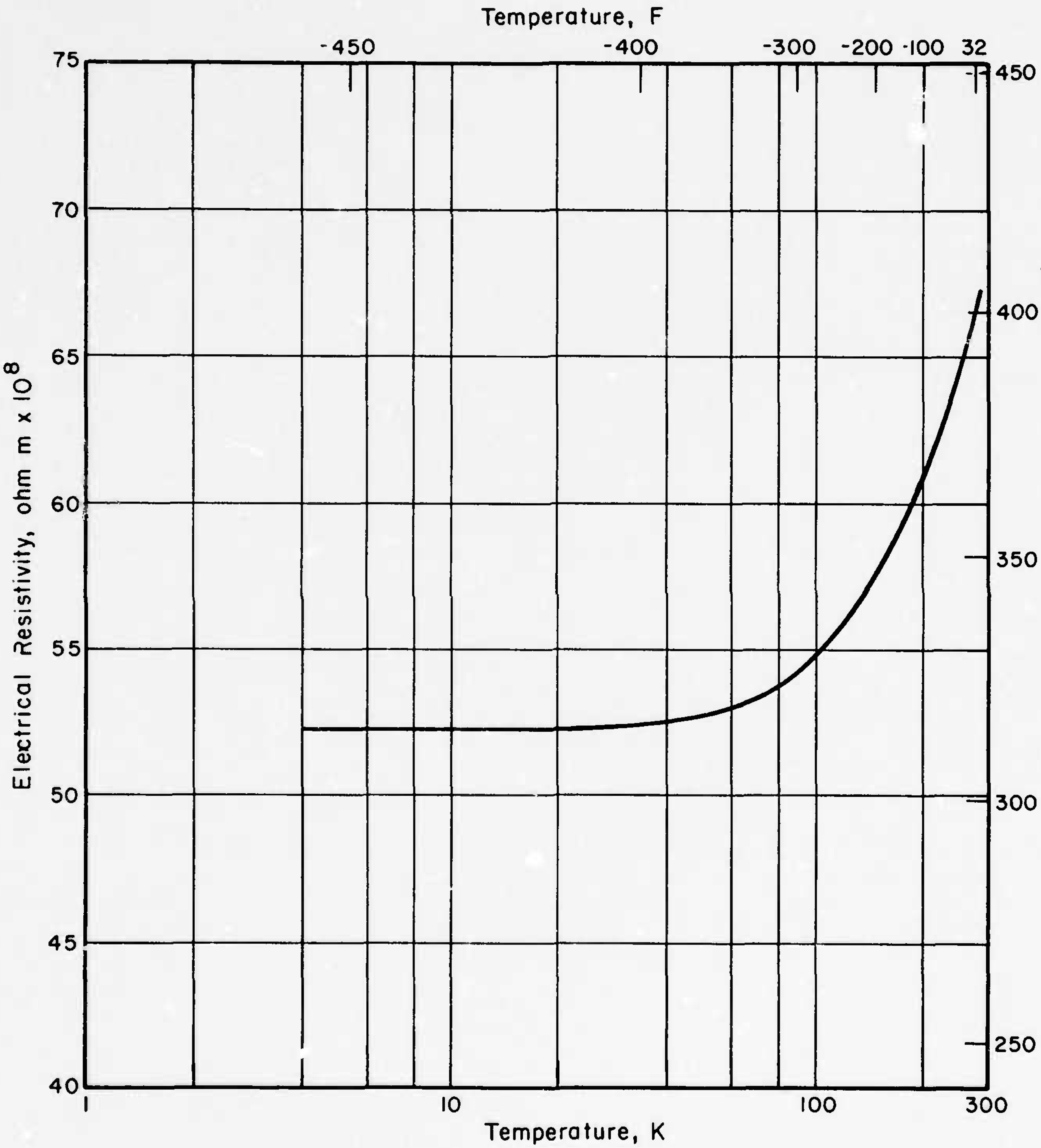

FIGURE 8.1.11-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 416 STAINLESS STEEL (Hardened)

TABLE 8.2.1-ME1

Alloy Designation: A-286 Stainless Steel

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed 1255 K (1800 F) 30 min, WQ, aged 865 K (1100 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1109 (161)		1486 (216)	1714 (249)		
	Min	1098 (159)		1475 (214)	1711 (248)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	632 (91.7)		796 (115)	915 (133)		
	Min	618 (89.7)		780 (113)	910 (132)		
Std. Deviation							
Elong, percent	Avg	17.7		15.3	24.7		
	Min	17.0		15.0	22.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1062 (154)		1271 (184)	1528 (222)		
K_t = 3.2	Min	1044 (151)		1239 (180)	1517 (220)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m^2 (ksi)	Avg	1022 (148)		1212 (176)	1377 (200)		
K_t = 6.3	Min	1011 (147)		1191 (173)	1359 (197)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1102 (160)		1468 (213)			
	Min	1098 (159)		1468 (213)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	659 (95.6)		868 (126)			
	Min	649 (94.1)		838 (122)			
Std. Deviation							
Elong, percent	Avg	22.0		29.8			
	Min	22.0		27.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1111 (161)		1338 (194)			
K_t = 3.2	Min						
No. of Spec. (No. of Heats)		1 (1)		1 (1)			
NTS, MN/m^2 (ksi)	Avg	1080 (157)		1282 (186)			
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)		1 (1)			

References: 39414

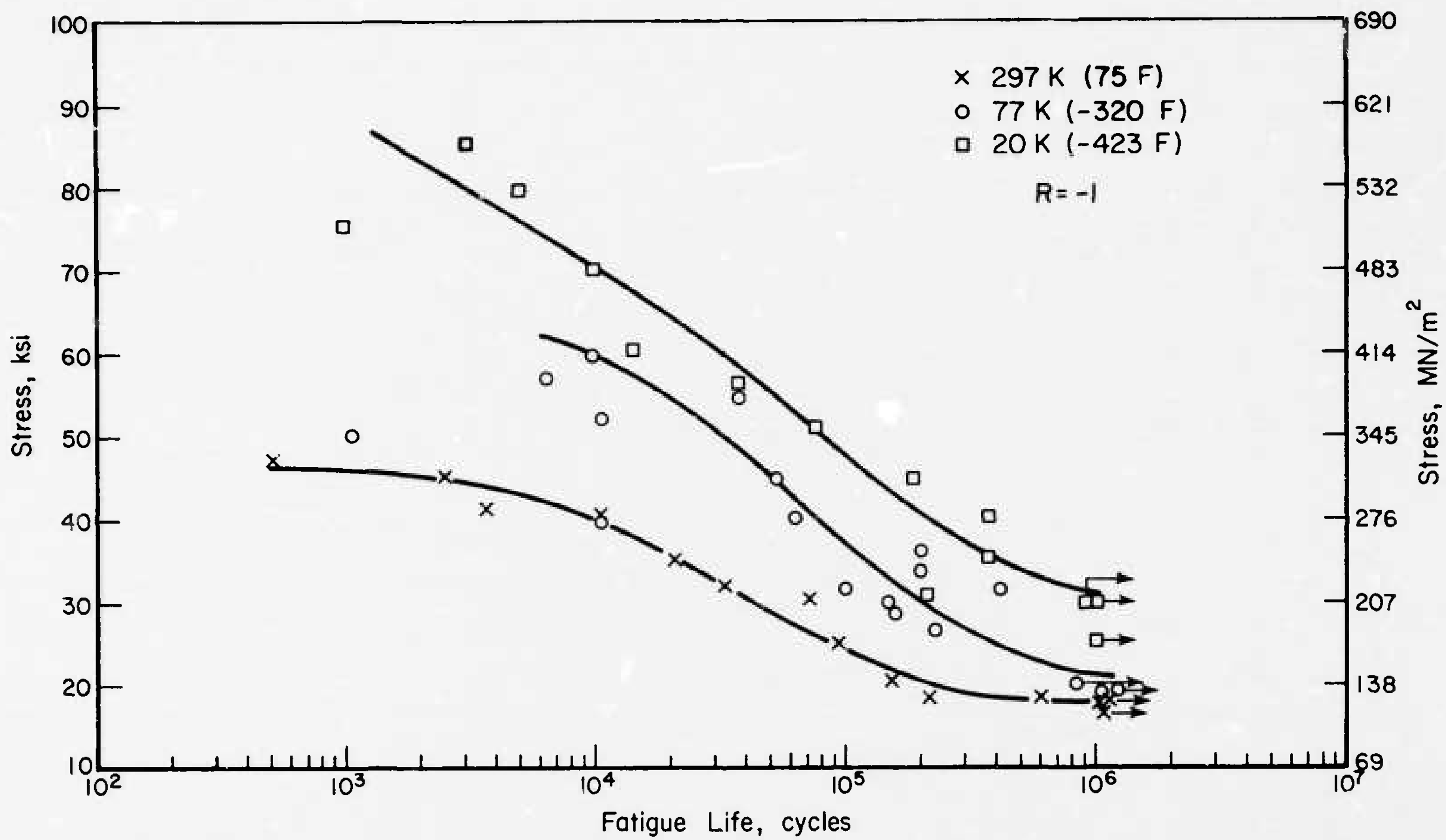

FIGURE 8.2.1-ME1.1. AXIAL FATIGUE PROPERTIES OF WELDED A-286 STAINLESS STEEL SHEET 0.319 cm (0.125 in.) THICK (STA Sheet TIG Welded, Hastelloy W filler, Tested as Welded) [61996]

TABLE 8.2.1-ME2

Alloy Designation: A-286 Stainless Steel

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed 1255 K (1800 F) 30 min, WQ, aged 990 K (1325 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1034 (150)		1400 (203)	1603 (232)		
	Min	1028 (149)		1397 (203)	1586 (230)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	668 (96.9)		839 (122)	956 (139)		
	Min	658 (95.5)		793 (115)	945 (137)		
Std. Deviation							
Elong, percent	Avg	14.5		22.3	17.7		
	Min	13.5		21.0	17.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1050 (152)		1241 (180)			
K_t = 3.2	Min	1047 (152)		1197 (174)			
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
NTS, MN/m^2 (ksi)	Avg	1015 (147)		1228 (178)	1401 (203)		
K_t = 6.3	Min	1014 (147)		1211 (176)	1393 (202)		
No. of Spec. (No. of Heats)		2 (1)		3 (1)	3 (1)		
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1042 (151)		1382 (200)			
	Min	1036 (150)		1362 (198)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	729 (106)		889 (129)			
	Min	720 (105)		878 (127)			
Std. Deviation							
Elong, percent	Avg	19.3		27.0			
	Min	19.0		26.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1081 (157)		1919 (191)			
K_t = 3.2	Min						
No. of Spec. (No. of Heats)		1 (1)		1 (1)			
NTS, MN/m^2 (ksi)	Avg	1093 (158)		1296 (188)			
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)		1 (1)			

References: 39414

TABLE 8.2.1-ME5

Alloy Designation: A-286 Stainless Steel

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed 1255 K (1800 F) 30 min, WQ or AQ, aged 990 K (1325 F) 16 hr, AC

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 72 rms						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency 30-40 Hz with R = -1 and K_t = 1	538 (78)		703 (102)	772 (112)		
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.52		0.52	0.52		
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency 30-40 Hz with R = -1 and K_t = 1	427 (62)		579 (84)	586 (85)		
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.42		0.43	0.40		
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency 30-40 Hz with R = -1 and K_t = 1	400 (58)		517 (75)			
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.39		0.38			
Fatigue, Flexural Loading, Surface Finish 10 rms						
S_N at 10^5 cycles, MN/m^2(ksi) Loading frequency 30-40 Hz with R = -1 and K_t = 1	593 (86)		758 (110)	869 (126)		
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.56		0.55	0.55		
S_N at 10^6 cycles, MN/m^2(ksi) Loading frequency 30-40 Hz with R = -1 and K_t = 1	496 (72)		703 (102)	779 (113)		
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.47		0.51	0.50		
S_N at 10^7 cycles, MN/m^2(ksi) Loading frequency 30-40 Hz with R = -1 and K_t = 1	434 (63)		676 (98)			
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.41		0.49			

References: 83417

TABLE 8.2.1-ME5.1

Alloy Designation: A-286 Stainless Steel (Weld Metal) K66286

Specification:
Form: Sheet-TIG welded, A-286 filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed sheet welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	4 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	641 (93.0)	727.4 (105.5)	801.2 (116.2)	981.8 (142.4)	1068 (154.9)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	301 (43.7)	354 (51.4)	412 (59.8)	507 (73.6)	613 (88.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	34.0	33.0	42.2	47.0	32.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 53548

TABLE 8.2.1-ME5.2

Alloy Designation: A-286 Stainless Steel (Weld Metal) K66286

Specification:
Form: Sheet-TIG welded, A-286 filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed sheet welded, age hardened, and tested as aged

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	861.2 (124.9)	930.8 (135.0)	1007 (146.0)	1145 (166.1)	1286 (186.5)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	601 (87.2)	610 (88.9)	669 (97.0)	743.9 (107.9)	866.0 (125.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	11.0	13.2	12.8	15.8	15.3	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 53548

TABLE 8.2.1-ME5.3

Alloy Designation: A-286 Stainless Steel (Weld Metal) K66286

Specification:
Form: Sheet-TIG welded, A-286 filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Age hardened sheet welded, and tested as welded

Testing Temperature, K (F)		297 (75)	915 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	685 (99.3)	780.5 (113.2)	877.7 (127.3)	948.0 (137.5)	1069 (155.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	386 (56.0)	472 (68.4)	543 (78.8)	601 (87.2)	717.1 (104.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.8	8.0	11.0	9.0	7.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 53648

6[illegible]

TABLE 8.2.1-ME5.4

Alloy Designation: A-286 Stainless Steel (Weld Metal)

Specification:
Form: Sheet-TIG welded, Hastelloy W filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: STA sheet welded and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	608 (88.2)			886.7 (128.6)	1005 (145.8)	
	Min	605 (87.8)			835.6 (121.2)	1004 (145.6)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 61996

TABLE 8.2.1-ME6

Alloy Designation: A-286 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed 1255 K (1800 F) 1.5 hr, AC, aged 1006 K (1350 F) 16 hr, AC

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Compression, Longitudinal											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Compression, Transverse											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Shear[a]											
SUS, MN/m^2 (ksi)	Avg	696	(101)	593	(86.0)	731	(106)	1158	(168)		
	Min										
No. of Spec. (No. of Heats)			(1)		(1)		(1)		(1)		
G, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Impact, Charpy V											
Long., Nm(ft-lb)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Trans., Nm(ft-lb)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Fracture Toughness[b]											
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg										
	Min										
Orientation: —											
No. of Spec. (No. of Heats)											
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg										
(From PTSC spec.)(—)	Min										
No. of Spec. (No. of Heats)											

References: 65182

(a) *Indicate specimen design and orientation for shear specimens:* 0.394 cm (0.155 in.) diameter
(b) Indicate specimen design for K_{Ic} data:

6[illegible]

TABLE 8.2.1-ME9

Alloy Designation: A-286 Stainless Steel

Specification: AMS-5735
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed 1255 K (1800 F) 1.5 hr, AC, aged 992 to 1006 K (1325 to 1350 F) 16 hr, AC

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)			
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear[a]										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., J(ft-lb)	Avg	75.2	(55.5)	77.3	(57.0)	70.8	(52.2)			
	Min	74.6	(55.0)	74.6	(55.0)	70.5	(52.0)			
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)			
Trans., J(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness[b]										
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg									
	Min									
Orientation —										
No. of Spec. (No. of Heats)										
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg									
(From PTSC spec.)(—)	Min									
No. of Spec. (No. of Heats)										

References: 54986

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

65[illegible]

TABLE 8.2.1-ME9.1

Alloy Designation: A-286 Stainless Steel K66286

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Cold worked 40% (min.) and aged

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1382 (200.5)	1500 (217.5)	1570 (227.6)	1761 (255.9)	1938 (281.1)	
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1288 (186.8)	1372 (199.0)	1420 (206.0)	1531 (222.1)	1681 (243.8)	
	Min						
Std. Deviation							
Elong, percent	Avg	13.1	16.0	16.2	19.5	19.3	
	Min						
RA, percent	Avg	41.9	42.4	42.0	40.1	33.9	
	Min						
No. of Spec. (No. of Heats)		12 (4)	10 (3)	11 (3)	14 (4)	17 (4)	
E, GN/m^2 (10^6 psi)	Avg	207 (30.0)	210 (30.4)	213 (30.9)	226 (32.8)	224 (32.5)	
	Min						
No. of Spec. (No. of Heats)		7 (2)	5 (1)	5 (1)	2 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	2164 (313.8)			2266 (328.7)	2388 (346.3)	
K_t = 10	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)	3 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 80755

TABLE 8.2.1-ME9.2

Alloy Designation:	A-286 Stainless Steel	K66286
Specification:		
Form:	Bar	
Thickness, cm (in.):	Up to 2.540 (1.000)	
Condition:	Cold worked 40% (min.) and aged	

Testing Temperature, K (F)		297 (75)			77 (-320)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear[a]							
SUS, MN/m^2 (ksi)	Avg	763.9 (110.8)			1042 (151.1)		
	Min						
No. of Spec. (No. of Heats)		4 (1)			3 (1)		
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	27.7 (20.5)			26.6 (19.7)		
	Min						
No. of Spec. (No. of Heats)		11 (3)			11 (3)		
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness[b]							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{in.}$)	Avg						
(From PTSC spec.)(—)	Min						
No. of Spec. (No. of Heats)							

References: 80755

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 8.2.1-ME10

Alloy Designation:	A-286 Stainless Steel	K66286
Specification:		
Form:	Square Bar	
Thickness, cm (in.):	Over 5.080 (2.000)	
Condition:	Solution treated 1170 K (1650 F) 2 hr., OQ + aged 1005 K (1350 F) 16hr., AC	

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	607 (88)	745 (108)	889 (129)			
	Min	572 (83)	734 (106.5)	887 (128.7)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References. 94206B

65 ,<

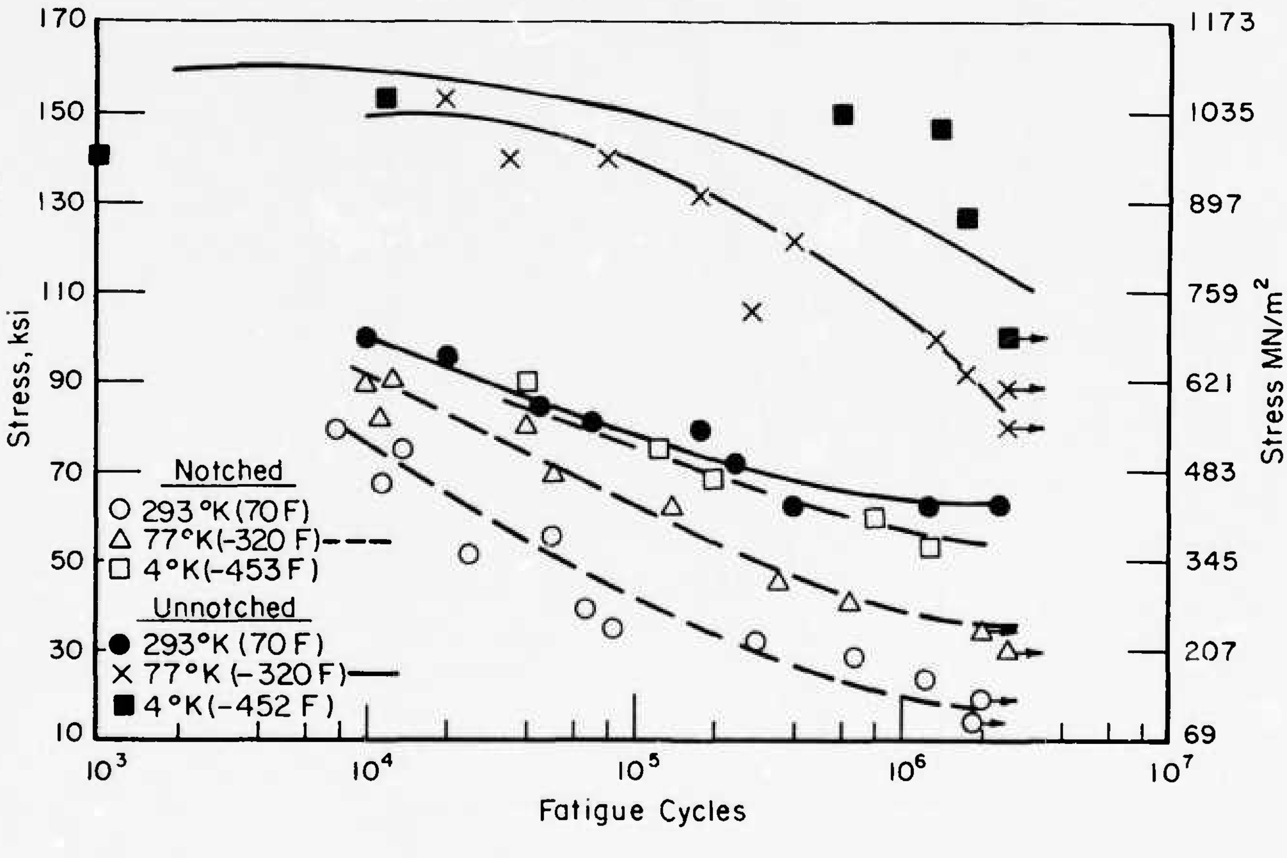

FIGURE 8.2.1-ME2.1. AXIAL FATIGUE LIFE CURVES FOR 1.27 cm (0.50 in.) DIAMETER BAR OF SOLUTION TREATED AND AGED A-286 STAINLESS STEEL [95168]

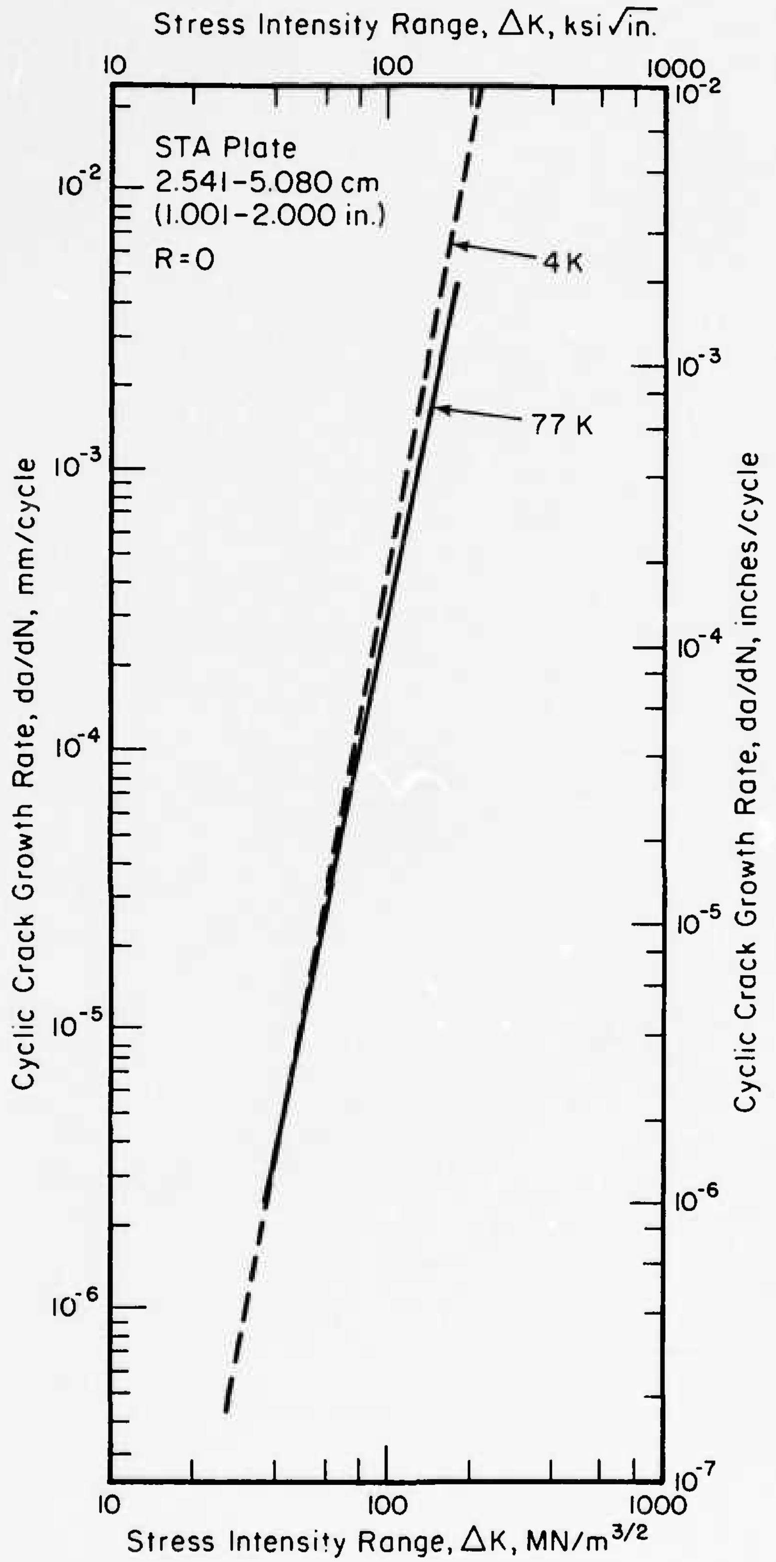

FIGURE 8.2.1-ME2: FATIGUE CRACK GROWTH RATE PROPERTIES OF A-286 STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94206A)

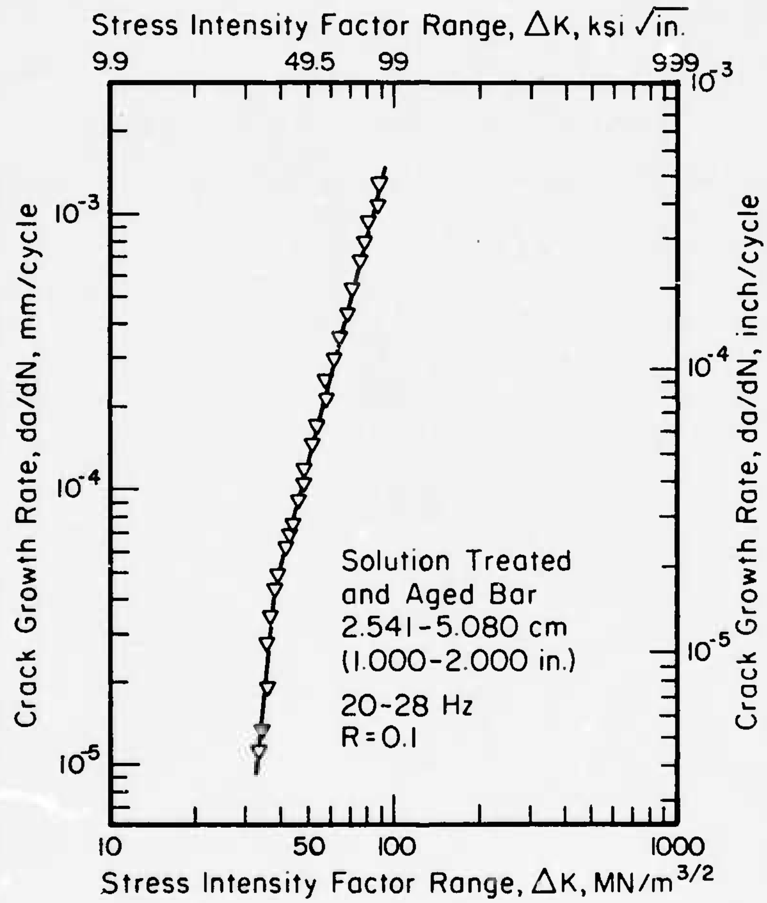

FIGURE 8.2.1-ME3. FATIGUE CRACK GROWTH RATES OF A-286 ALLOY (ASTM A453) AT 4K (-452F)(94208D)

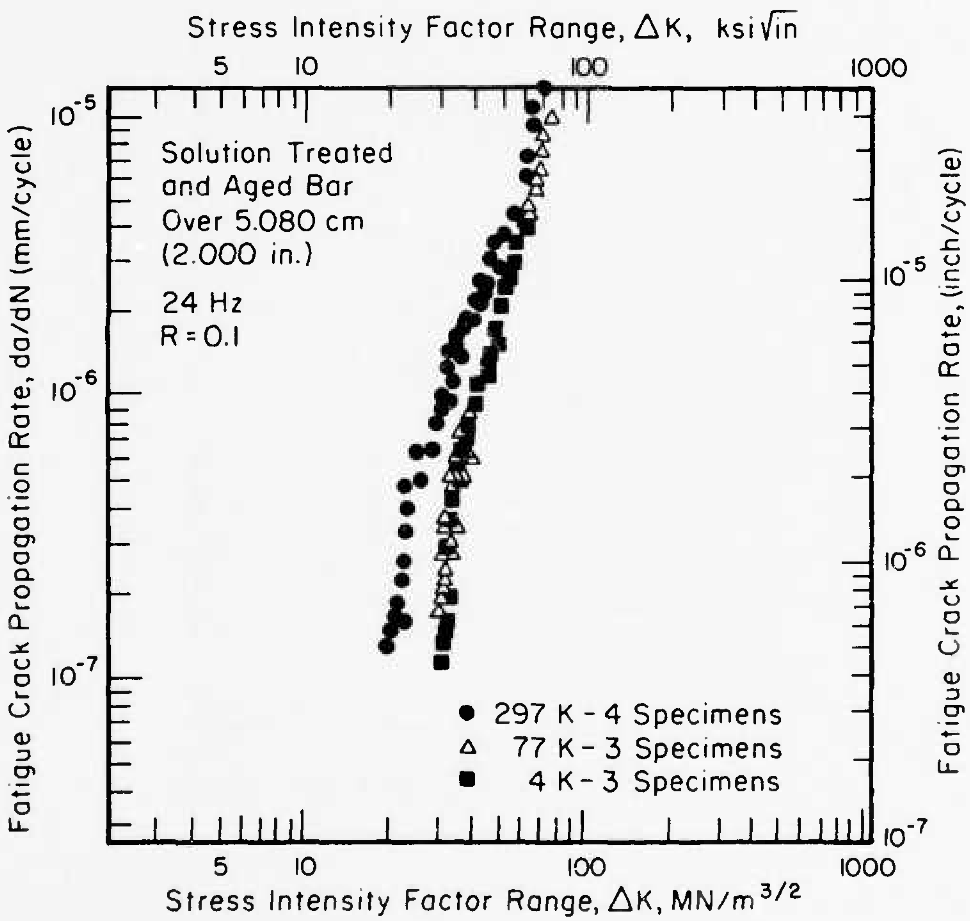

FIGURE 8.2.1-ME4. FATIGUE CRACK GROWTH RATES FOR A-286 AT 297K, 77K, AND 4K (75F, -320F, AND -452F)(94208E)

657

Alloy Designation:	A-286 Stainless Steel	K66286
Specification:		
Form:	Rod	
Diameter, cm (in.):	0.37 (0.145)	
Condition:	Solution annealed	
Test Temperature:	4.2 K (−452 F)	

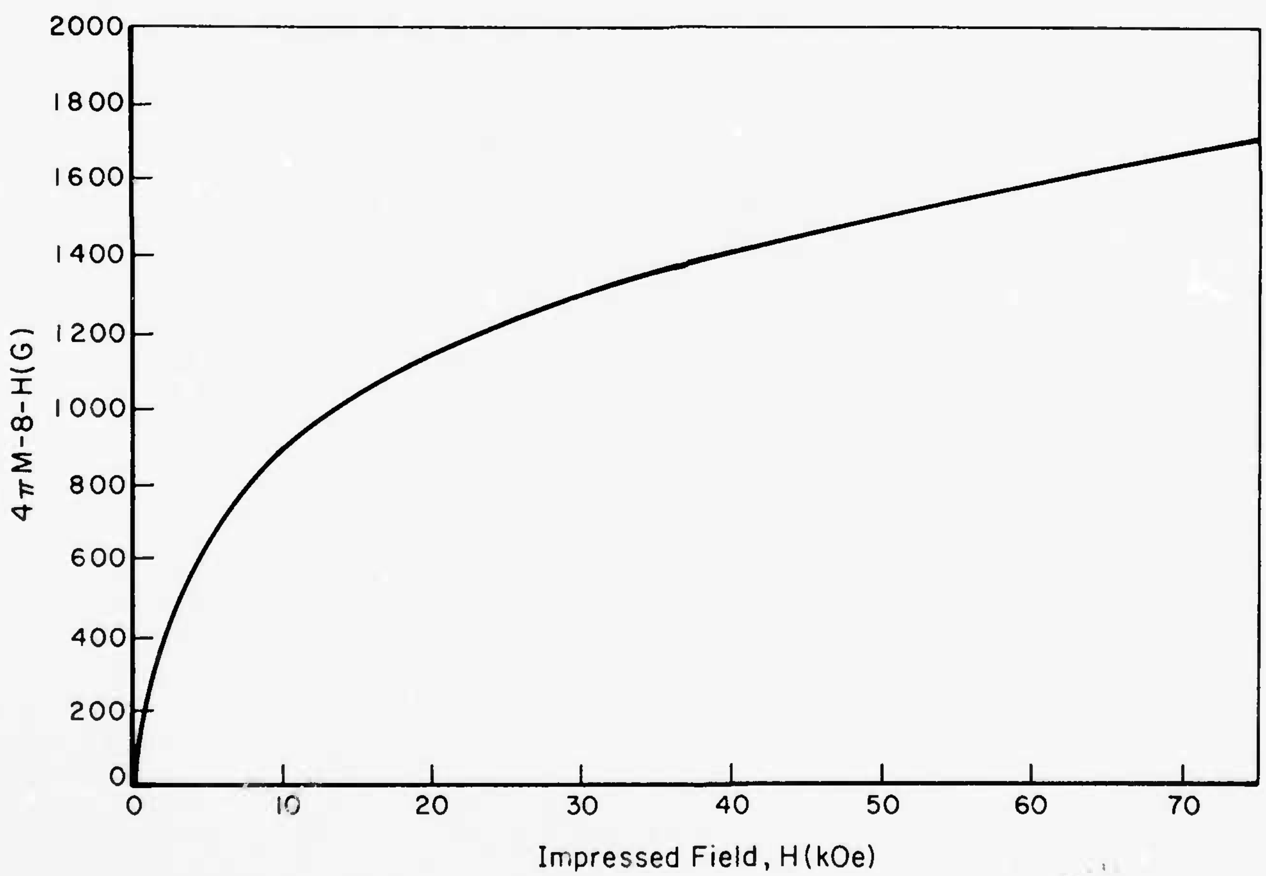

FIGURE 8.2.1-MA1. MAGNETIZATION VERSUS APPLIED MAGNETIC FIELD FOR A-286 STAINLESS STEEL [96871]

TABLE 8.2.2-ME10

Alloy Designation:	Kromarc 58 Stainless Steel (Weld Metal)
Specification:	
Form:	Plate-TIG welded, Kromarc 58 filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Plate heated 1255 K (1800 F) 1 hr, WQ, welded, and tested as welded

Testing Temperature, K (F)		297 (75)*			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	915.6 (132.8)			1321 (191.6)		1438 (208.6)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	498 (72.3)			852.2 (123.6)		1060 (153.8)
	Min						
Std. Deviation							
Elong, percent	Avg	35.9			45.6		33.4
	Min						
RA, percent	Avg	60.8			41.4		40.6
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1153 (167.3)			1908 (276.8)		2173 (315.2)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

* Room-temperature specimens fractures in base metal.

TABLE 8.2.2-ME11

Alloy Designation: Kromarc 58 Stainless Steel (Weld Metal)

Specification:
Form: Plate-TIG welded, Kromarc 58 filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate-cold worked 30%, welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	957.0 (138.8)			1303 (189.0)		1415 (205.3)
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	828.1 (120.1)			1111 (161.2)		1269 (184.1)
	Min						
Std. Deviation							
Elong, percent	Avg	12.9			12.6		11.4
	Min						
RA, percent	Avg	57.6			45.7		42.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1108 (160.7)			1919 (278.3)		2149 (311.7)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 8.2.2-ME12

Alloy Designation: Kromarc 58 Stainless Steel (Weld Metal)

Specification:
Form: Plate-TIG welded, Kromarc 58 filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate-cold worked 30%, welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1223 (177.4)			1474 (213.8)		1571 (227.9)
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg	1138 (165.0)			1260 (182.8)		1389 (201.4)
	Min						
Std. Deviation							
Elong, percent	Avg	8.0			17.5		13.4
	Min						
RA, percent	Avg	43.6			37.6		33.9
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1547 (224.4)			2216 (321.4)		2366 (343.2)
K_t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

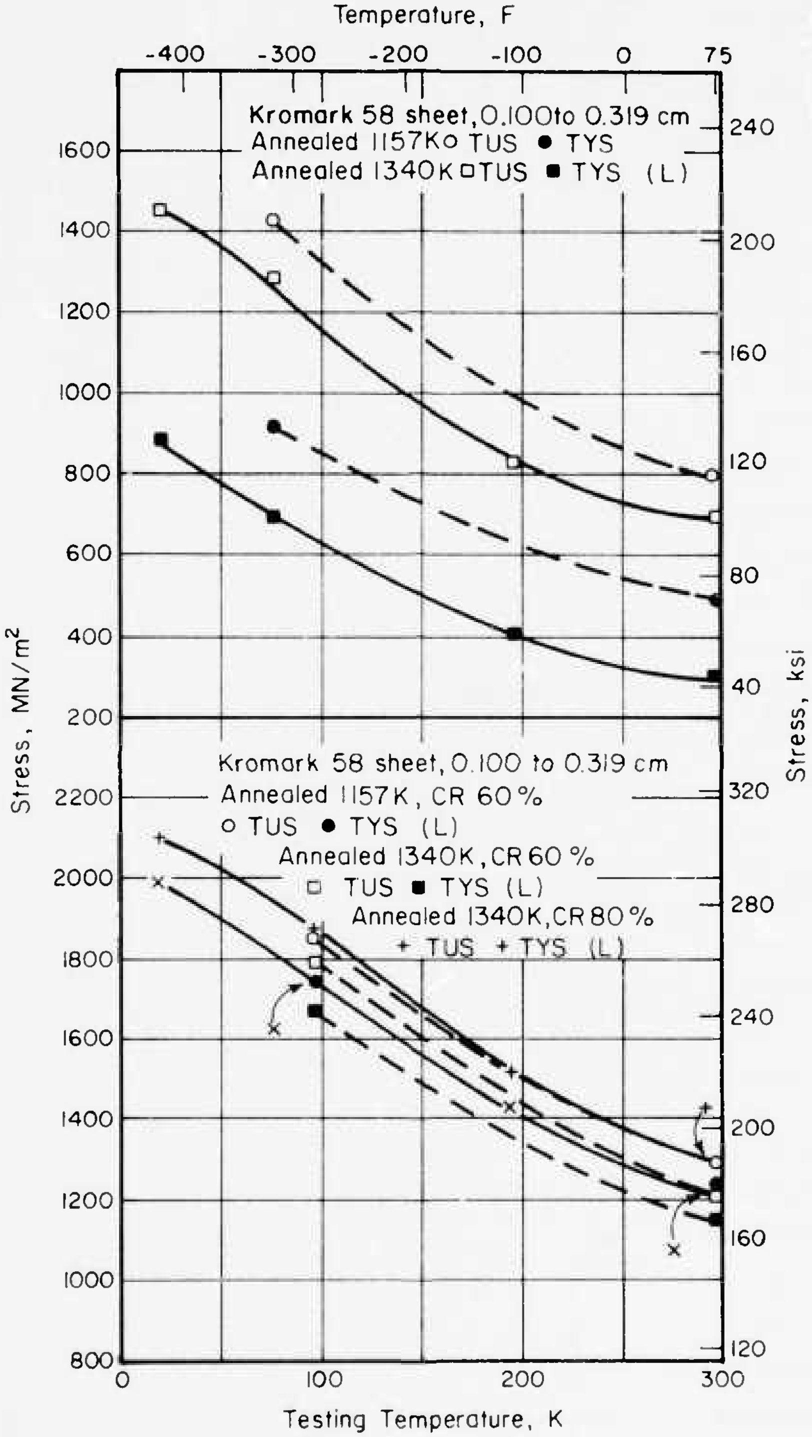

FIGURE 8.2.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF KROMARC 58 STAINLESS STEEL SHEET

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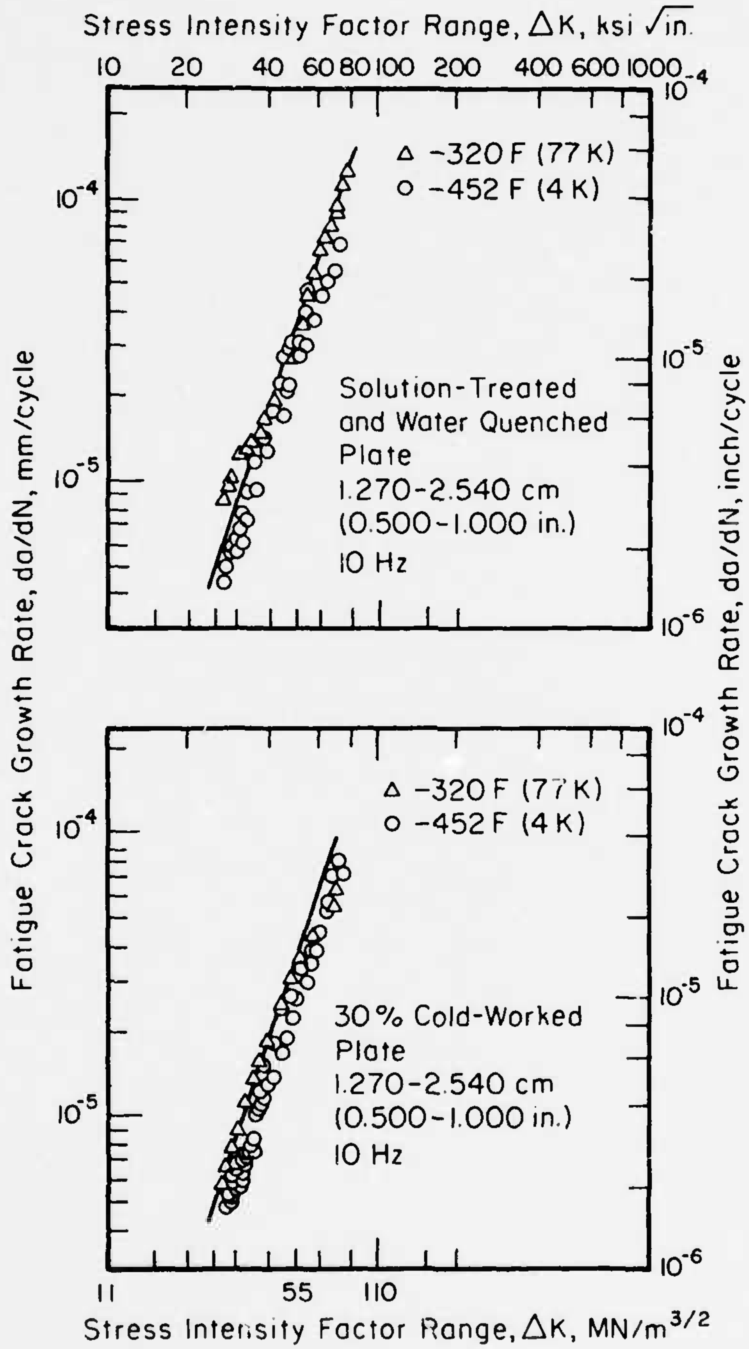

FIGURE 8.2.2-ME2. FATIGUE CRACK GROWTH RATE PROPERTIES OF KROMARC 58 STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94208G)

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TABLE 8.2.2-TR1

Alloy Designation: Kromarc 58 Stainless Steel

Specification:
Form:
Dimension:
Condition: Solution Treated and Quenched

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}	11.5	6.8	4.2	1.55	0.72	
Btu hr^{-1} ft^{-1} F^{-1}	(6.65)	(3.93)	(2.43)	(0.896)	(0.416)	
No. of Spec.	1	1	1	1	1	
References: 94206						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.238	-0.270	-0.274	-0.275	-0.275
No. of Spec.	2	2	1	1	1	1
References: 47125, 90202						
Specific Heat						
Joules kg^{-1} K^{-1}					4.25	1.62
Btu lb^{-1} F^{-1}					(0.00102)	(0.000387)
No. of Spec.					2	2
References: 90202, 94206						
Electrical Resistivity						
Ohm m	96×10^{-8}	84×10^{-8}	82×10^{-8}	82×10^{-8}	82×10^{-8}	82×10^{-8}
Ohm circular mil ft^{-1}	(577)	(505)	(493)	(493)	(493)	(493)
No. of Spec.	1	1	1	1	1	1
References: 94206						

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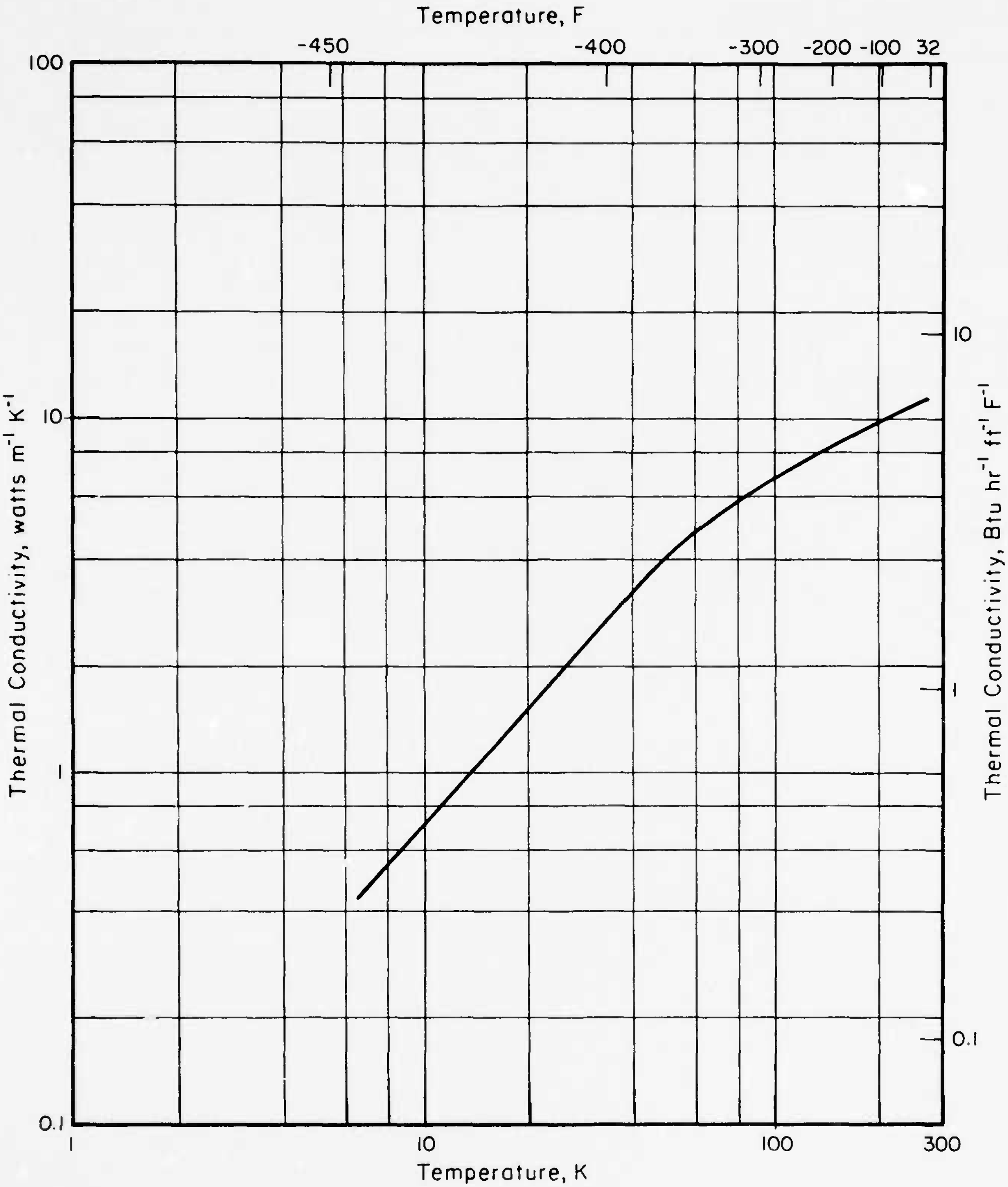

FIGURE 8.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR KROMARC 58 STAINLESS STEEL

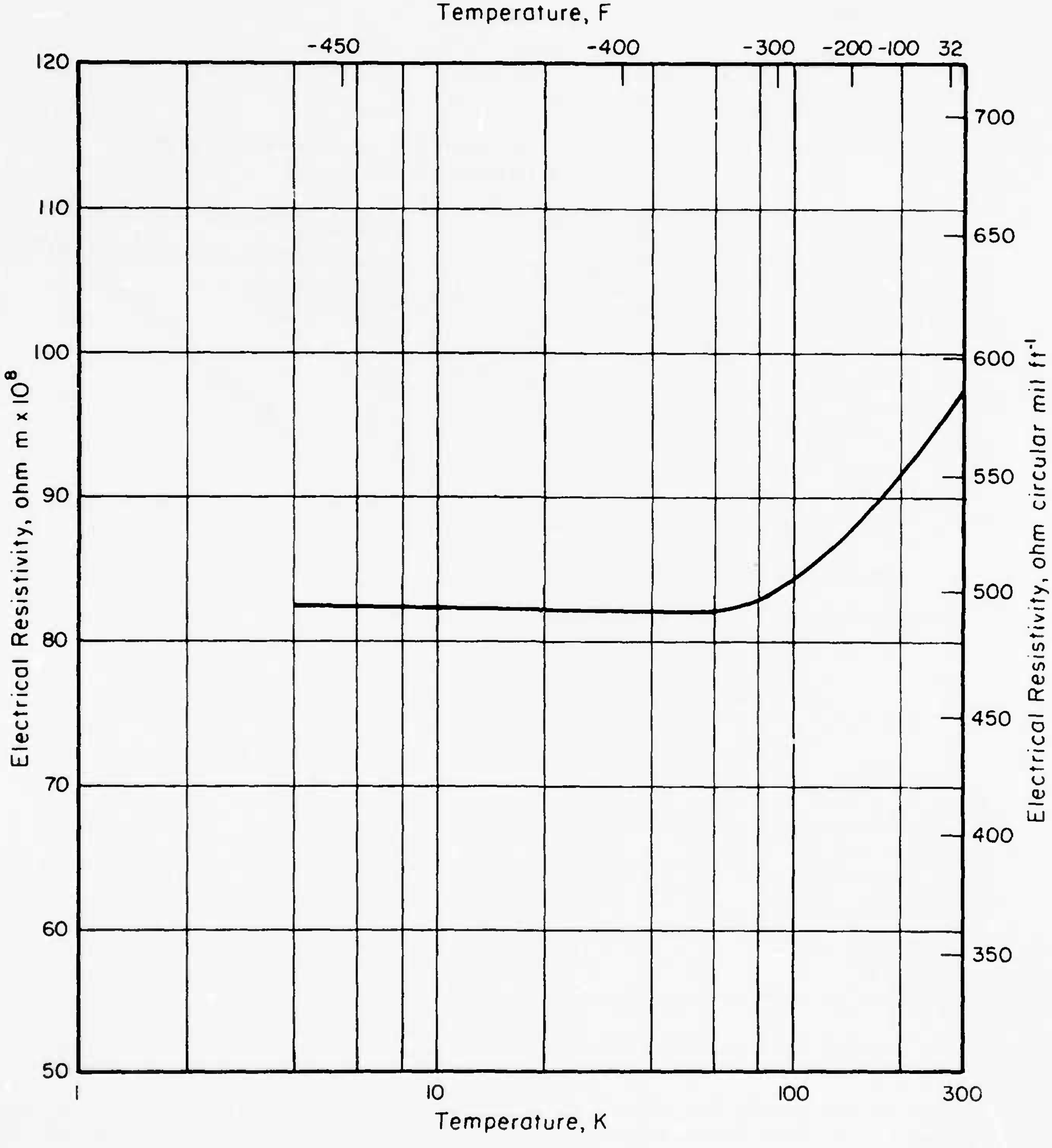

FIGURE 8.2.2-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR KROMARC 58 STAINLESS STEEL

TABLE 8.2.2-MA1

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Rod

Dimension, cm(in.): Not given

Condition: STQ: solution treated and quenched (1800 F [1255 K] 1 hr. and water quenched)

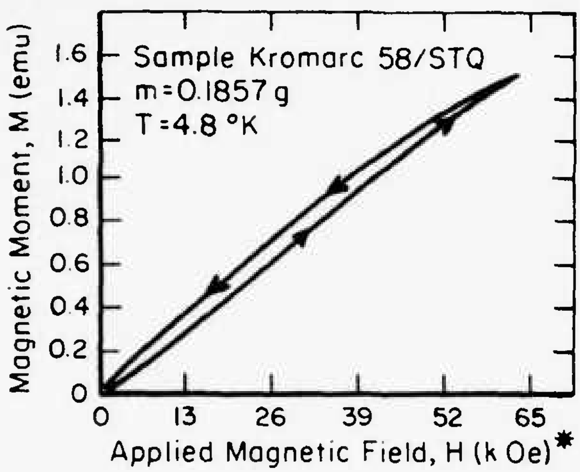

FIGURE 8.2.2-MA1.1. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

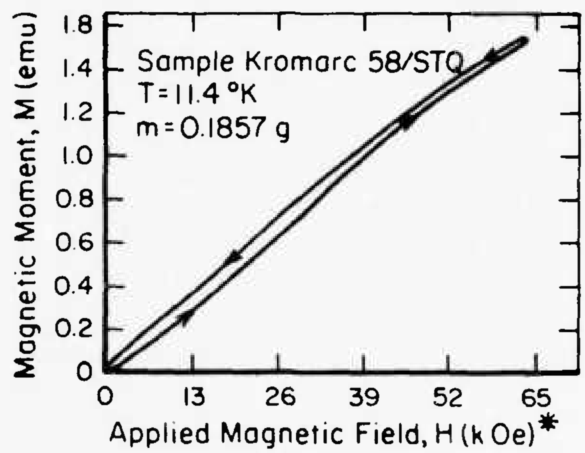

FIGURE 8.2.2-MA1.2. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

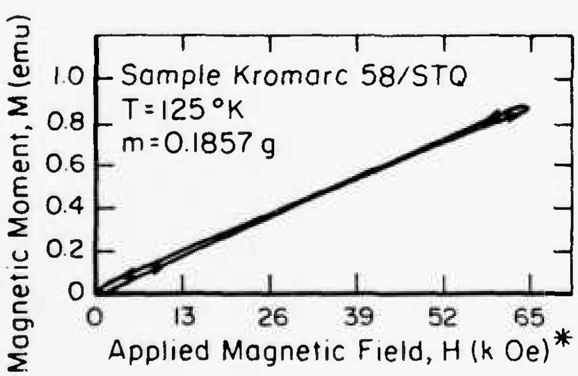

FIGURE 8.2.2-MA1.3. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

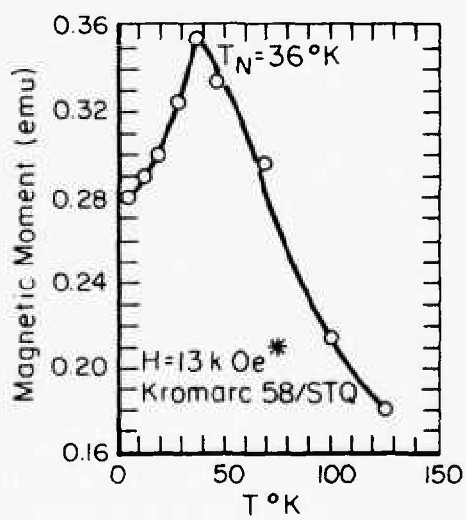

FIGURE 8.2.2-MA1.4. MAGNETIC MOMENT AT 13 k Oe AS A FUNCTION OF THE TEMPERATURE

* 1 tesla = 10kOe

Reference 94206

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TABLE 8.2.2-MA2

Alloy Designation: Kromarc 58 Stainless Steel

Form: Rod

Dimension, cm (in.): Not given

Condition: CW: cold worked to about 30 percent reduction in thickness

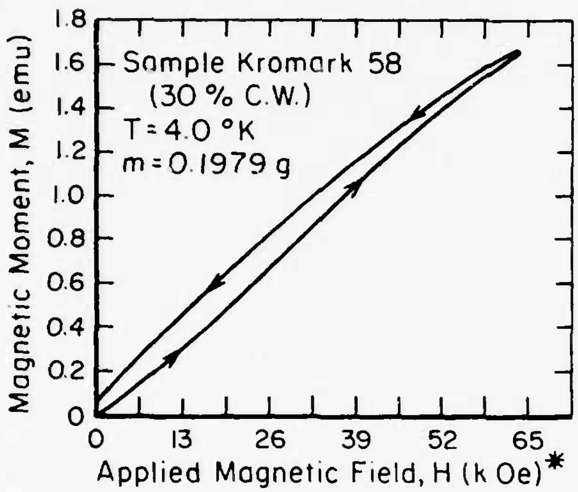

FIGURE 8.2.2-MA2.1. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

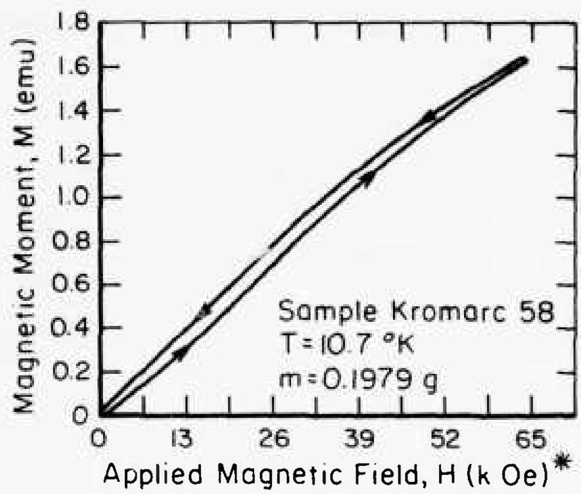

FIGURE 8.2.2-MA2.2. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

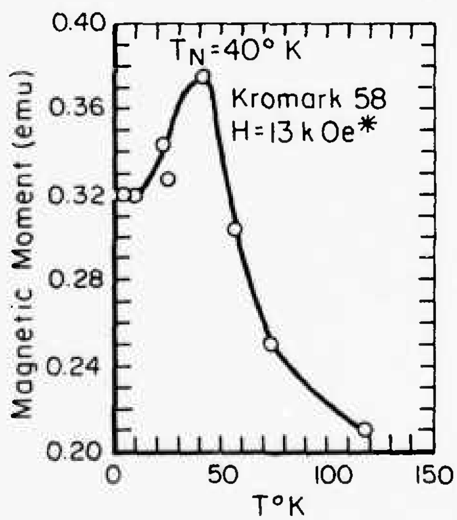

FIGURE 8.2.2-MA2.3. MAGNETIC MOMENT AT 13 k Oe AS A FUNCTION OF THE TEMPERATURE

* I tesla = 10kOe
Reference 94206

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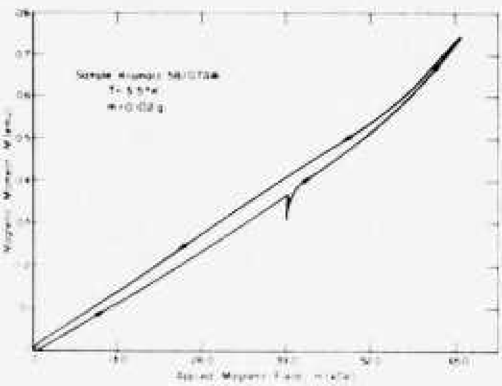
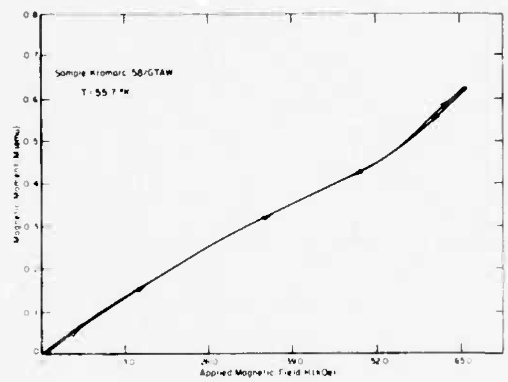
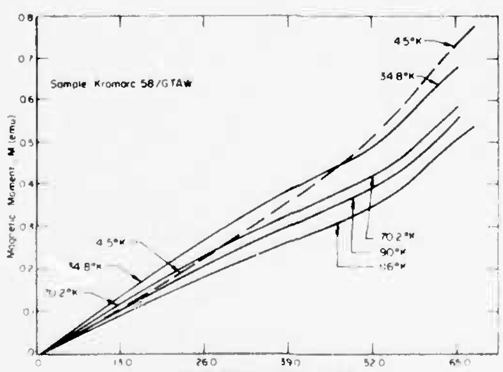
TABLE 8.2.2-MA3

Alloy Designation:	**Kromarc 58 Stainless Steel**
Specification:	**Kromarc 58 GTAW**
Form:	**Rod**
Dimension, cm (in.):	**0.305 (0.12)**
Condition:	**Gas tungsten arc welded (GTAW)**



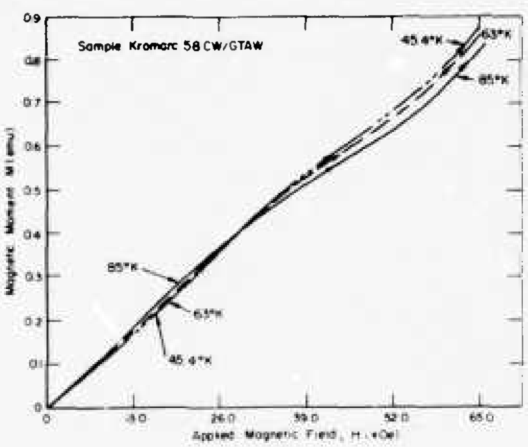


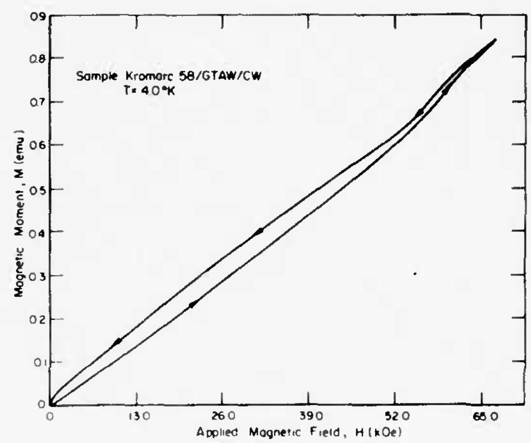


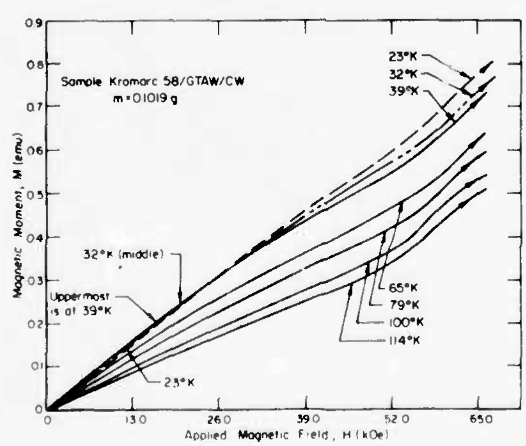
MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD [94206]

TABLE 8.2.2-MA4

Alloy Designation:	**Kromarc 58 Stainless Steel**
Specification:	**58 GTAW/CW**
Form:	**Rod**
Dimension, cm (in.):	**0.305 (0.12)**
Condition:	**GTAW/CW: Gas tungsten arc welded and cold worked to about 30% reduction in thickness**



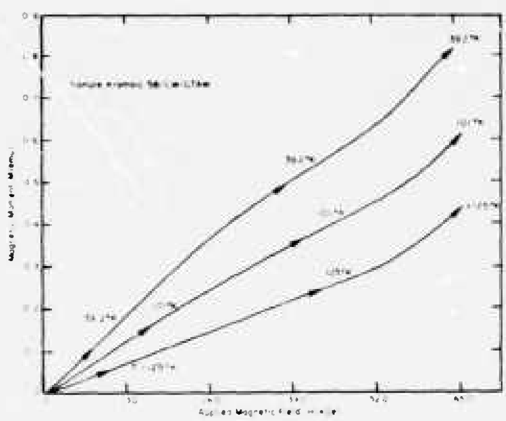


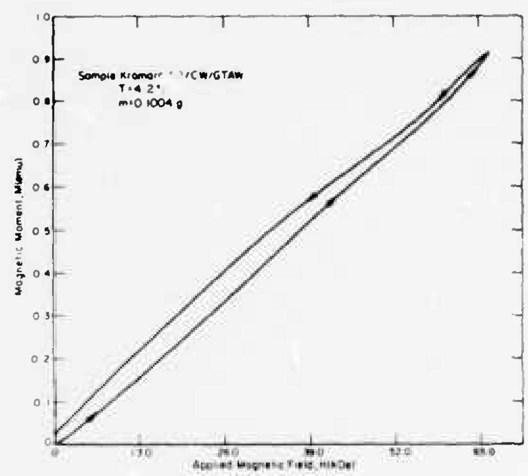


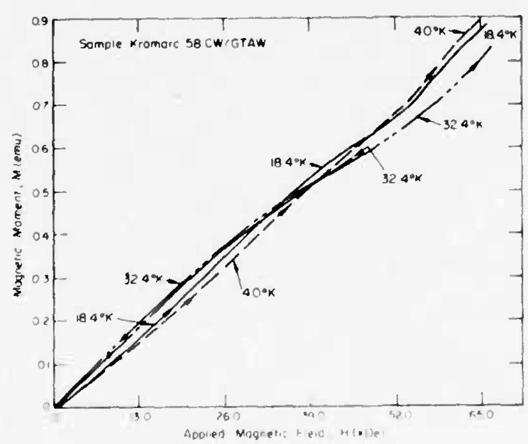
MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD [94206]

TABLE 8.2.2-MA5

Alloy Designation:	Kromarc 58 Stainless Steel
Specification:	Kromarc 58 CW/GTAW
Form:	Rod
Dimension, cm (in.):	0.305 (0.12)
Condition:	CW/GTAW: Cold worked to about 30% reduction in thickness and gas tungsten arc welded
Neel Temperature:	~40 K (-387 F)







MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD [94206]

TABLE 8.2.3-ME0.1

Alloy Designation: Armco 21-6-9 Stainless Steel

Specification:
Form: Plate
Thickness, cm (in.): 2.541 to 5.080 (1.000 to 2.000)
Condition: Annealed 1283 K (1850 F) 1½ hr, AC; annealed 1366 K (2000 F) 1½ hr, WQ

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	701 (102)			1474 (213.8)		1634 (237.0)
	Min	696 (101)			1462 (212.1)		1633 (236.9)
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	358 (51.2)			899 (130)		1241 (180.0)
	Min	350 (50.8)			886 (129)		1224 (177.5)
Std. Deviation							
Elong, percent	Avg	61			43		16
	Min	61			42		
RA, percent	Avg	78			37		40
	Min	78			32		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		2 (1)
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 8.2.3-ME1

Alloy Designation:	Armco 21-6-9 Stainless Steel
Specification:	
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Annealed 1340 K (1950 F) 1 hr., WQ

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	702 (101.8)	899 (130.4)	1510 (219.0)	1662 (241.0)		
	Min	688 (99.8)	889 (129.0)	1503 (218.0)	1579 (229.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	385 (55.9)	589 (85.4)	971 (140.9)	1219 (176.8)		
	Min	374 (54.2)	565 (82.0)	899 (130.4)	1108 (160.7)		
Std. Deviation							
Elong, percent	Avg	54.5	60.0	41.0	16.0*		
	Min	54.0	60.0	37.0	--		
RA, percent	Avg	79.6	74.8	32.8	46.0		
	Min	78.4	73.5	32.0	22.0		
No. of Spec. (No. of Heats)		4 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	704 (102.1)	917 (133.0)	1444 (209.5)	1682 (244.0)		
	Min	698 (101.2)	907 (131.5)	1400 (203.0)	1675 (243.0)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	392 (56.9)	581 (84.3)	962 (139.5)	1248 (181.0)		
	Min	374 (54.2)	502 (81.5)	889 (129.0)	1148 (166.5)		
Std. Deviation							
Elong, percent	Avg	51.0	58.0	34.0*	16.0		
	Min	47.0	57.0	--	15.0		
RA, percent	Avg	71.8	70.3	27.8	24.3		
	Min	65.0	69.5	24.0	20.5		
No. of Spec. (No. of Heats)		4 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 83166

* One specimen only

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TABLE 8.2.3-ME2

Alloy Designation:	Armco 21-6-9 Stainless Steel
Specification:	
Form:	Plate
Thickness, cm (in.):	Over 5.080 (2.000)
Condition:	Annealed 1340 K (1950 F) 1 hr., WQ

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	2- (-423)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	325^+ (240^+)	289 (213)	129 (95)	98 (72)		
	Min	325^+ (240^+)	286 (211)	122 (90)	--		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	1		
Trans., Nm(ft-lb)	Avg	278 (205.3)	198 (146)	78 (57.5)	64 (47.0)		
	Min	260 (192.0)	198 (146)	68 (50)	56 (41.0)		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
Fracture Toughness(b)							
K_{Ic} $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation: –							
No. of Spec. (No. of Heats)							
K_{IE}, $MN/m^{3/2}$(ksi$\sqrt{}$in.)	Avg						
(From PTSC spec.)(–)	Min						
No. of Spec. (No. of Heats)							

References: 83166

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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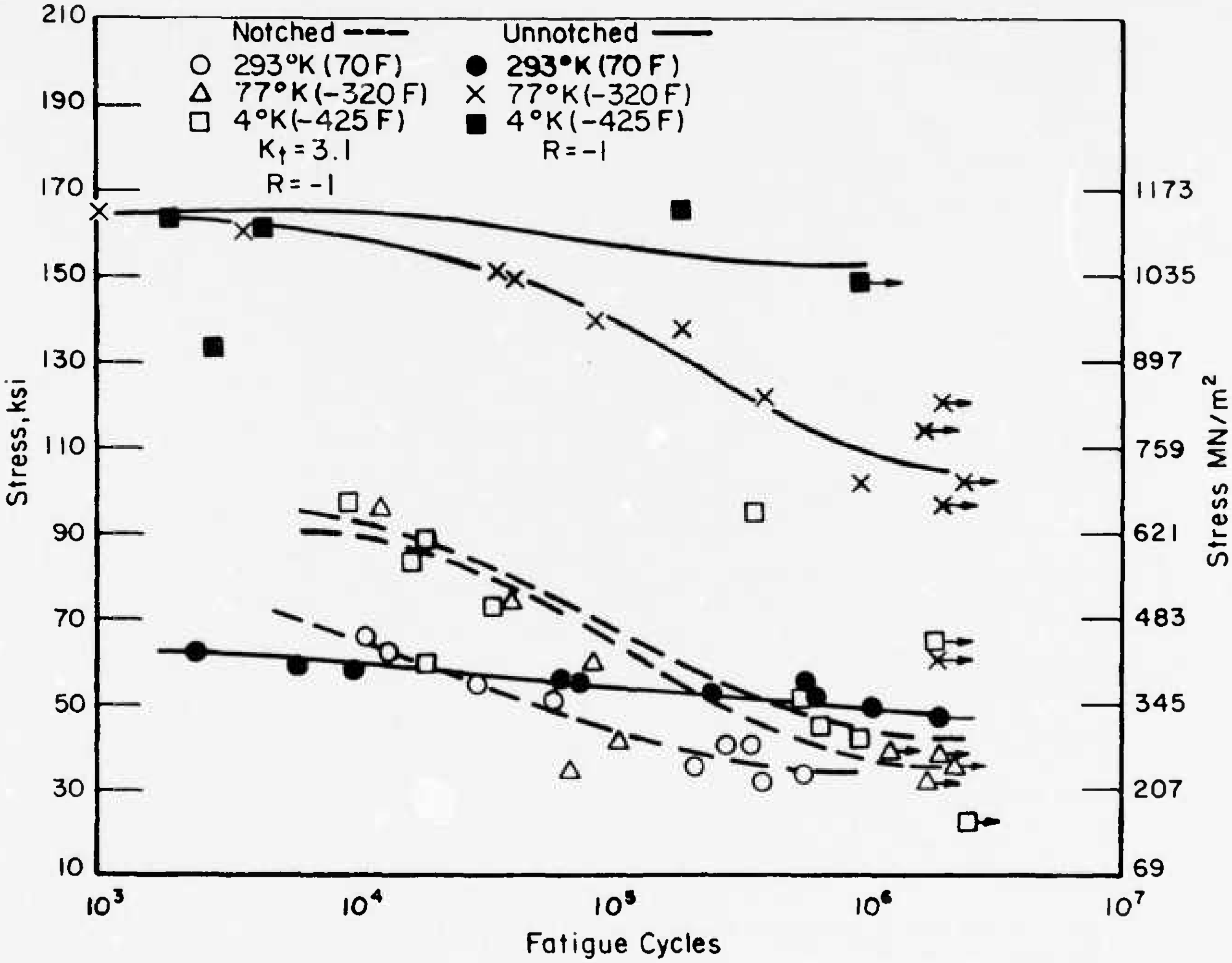

FIGURE 8.2.3-ME1. AXIAL FATIGUE-LIFE CURVES FOR 1.270 cm (0.500 in.) DIAMETER NOTCHED AND UNNOTCHED BAR SPECIMENS OF ANNEALED 21-6-9 STAINLESS STEEL [95168]

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TABLE 8.2.4-TR1

Alloy Designation: Fe-22Cr-13Ni-5Mn

Specification:
Form:
Dimension:
Condition: Furnace brazed

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	12.6		8.00		5.12		2.17		0.991			
Btu hr^{-1} ft^{-1} F^{-1}		(7.29)		(4.63)		(2.96)		(1.25)		(0.573)		
No. of Spec.	1		1		1		1		1			
References: 90196												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m	80.0×10^{-8}		65.8×10^{-8}		62.4×10^{-8}		62.1×10^{-8}		62.1×10^{-8}		62.2×10^{-8}	
Ohm circular mil ft^{-1}		(481)		(396)		(375)		(374)		(374)		(374)
No. of Spec.	1		1		1		1		1		1	
References: 90196												

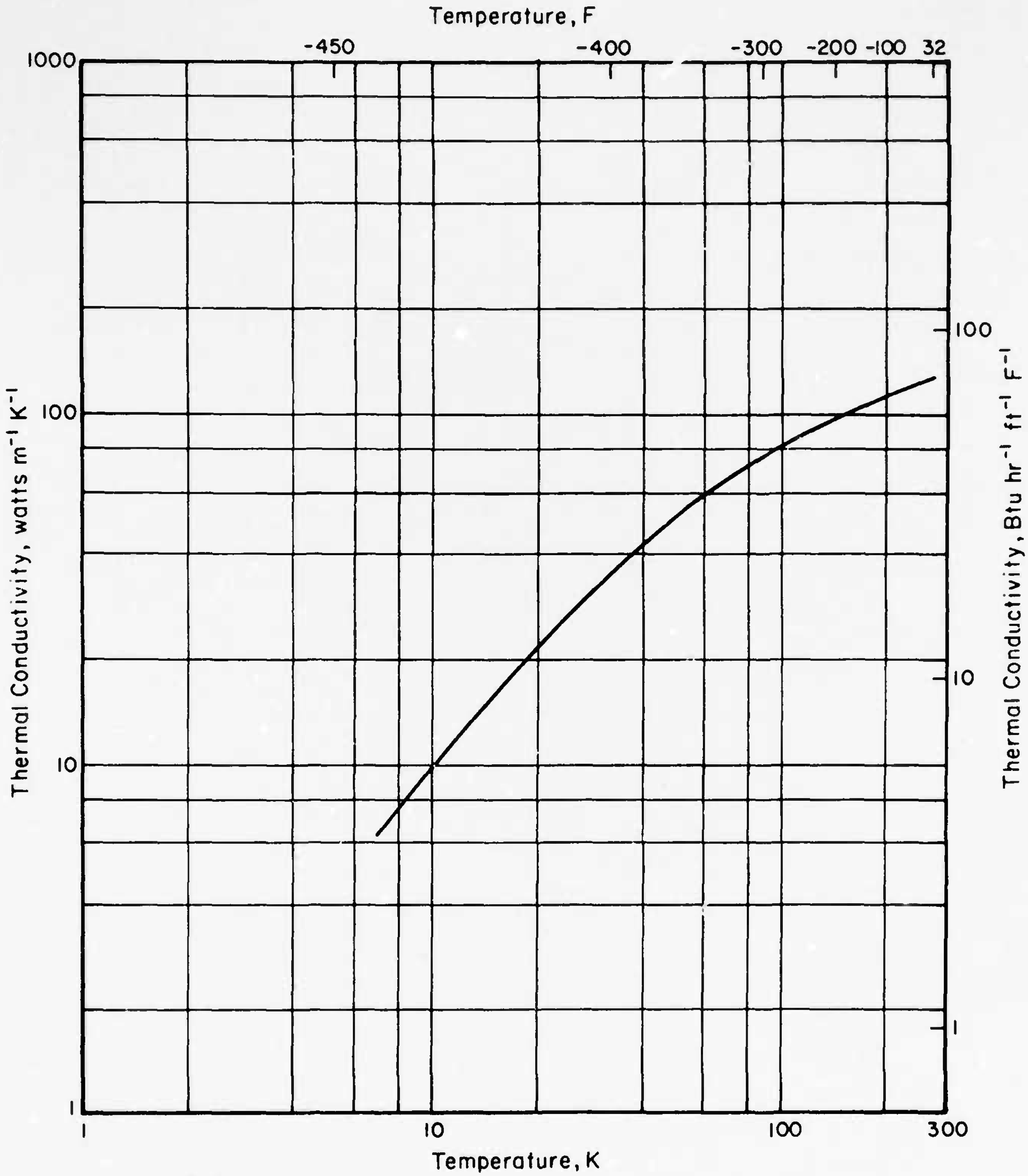

FIGURE 8.2.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR FE-22CR-13NI-5MN ALLOY (Furnace Brazed Condition)

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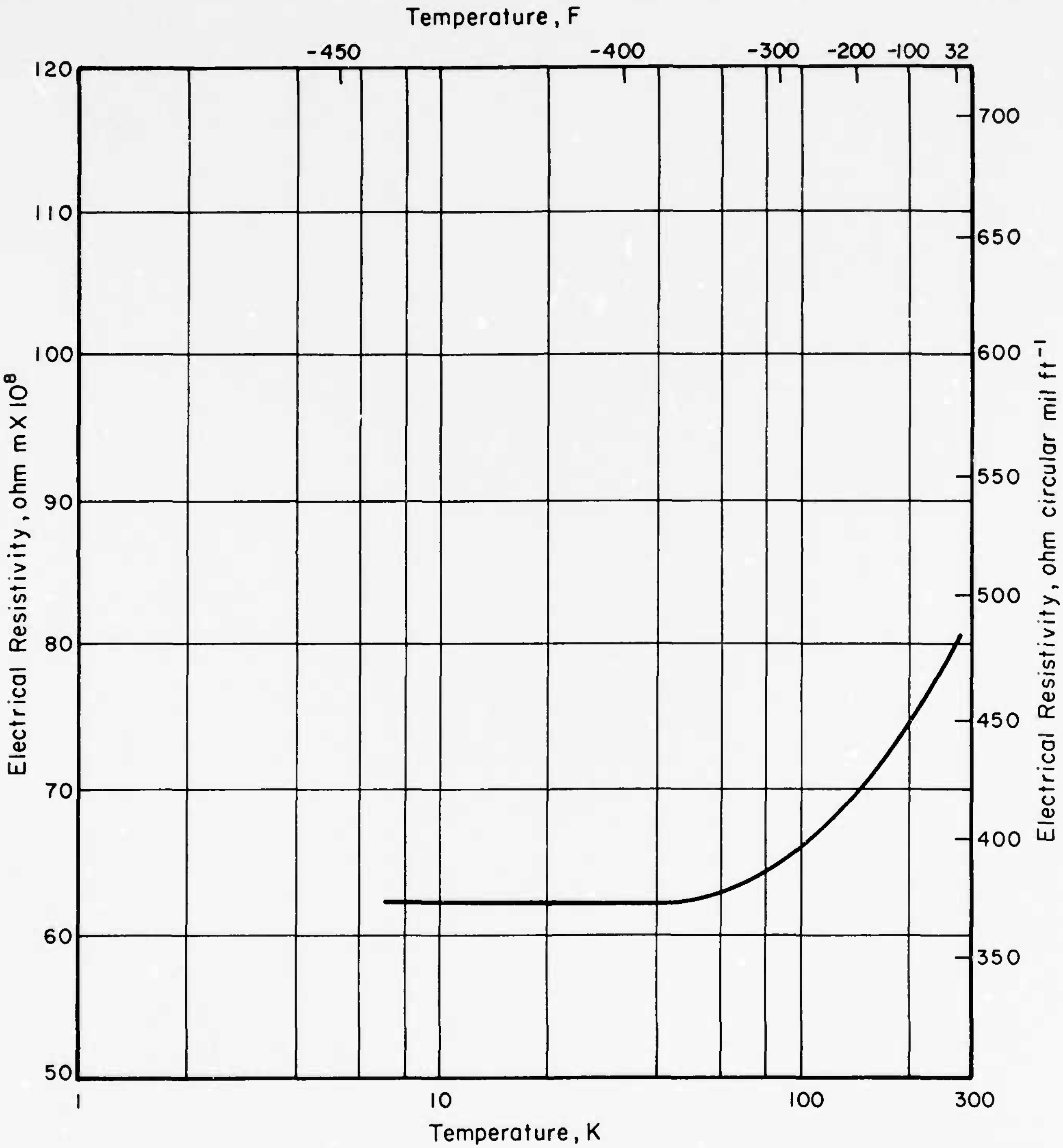

FIGURE 8.2.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR FE-22CR-13NI-5MN ALLOY (Furnace Brazed Condition)

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INDEX TO MATERIAL CODES FOR SECTION 9.0

TITANIUM AND TITANIUM ALLOYS

MATERIALS	MATERIAL CODE
Ti-65A	9.1.1
Ti-75A	9.1.2
Ti-5Al-2.5Sn (NORMAL INTERSTITIAL CONTENT)	9.2.1
Ti-5Al-2.5Sn (ELI)	9.2.2
Ti-6Al-4V (ELI)	9.3.1
Ti-6Al-4V (NORMAL INTERSTITIAL CONTENT)	9.3.2

TABLE 9.2.1-ME1

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	844	(122)	1037	(150)	1347	(195)	1686	(245)		
	Min	745	(108)	993	(144)	1234	(179)	1517	(220)		
Std. Deviation		62.8	(9.11)	55.2	(8.00)	78.6	(11.4)	88.9	(12.9)		
TYS, MN/m^2 (ksi)	Avg	785	(114)	957	(139)	1275	(185)	1576	(228)		
	Min	703	(102)	889	(129)	1186	(172)	1427	(207)		
Std. Deviation		49.8	(7.23)	50.2	(7.28)	52.1	(7.56)	87.6	(12.7)		
Elong, percent	Avg	15.2		13.6		13.6		6.3			
	Min	12		12.5		11		3			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		21	(9)	8	(2)	12	(3)	23	(9)		
E, GN/m^2 (10^6 psi)	Avg	106	(15.4)	114	(16.6)	122	(17.7)	127	(18.5)		
	Min	93	(13.5)	109	(15.8)	117	(17.0)	116	(16.9)		
No. of Spec. (No. of Heats)		10	(2)	5	(1)	9	(2)	8	(2)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1121	(163)	1233	(179)	1644	(238)	1480	(215)		
K_t = 6.3	Min	1014	(147)	1131	(164)	1600	(232)	1338	(194)		
No. of Spec. (No. of Heats)		12	(7)	6	(2)	6	(2)	13	(7)		
NTS, MN/m^2 (ksi)	Avg	947	(137)	976	(142)	956	(139)	831	(120)		
K_t = 19+	Min	848	(123)	869	(126)	862	(125)	758	(110)		
No. of Spec. (No. of Heats)		7	(2)	5	(1)	5	(1)	8	(2)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	872	(126)	1016	(147)	1398	(203)	1695	(246)		
	Min	807	(117)	979	(142)	1344	(195)	1579	(229)		
Std. Deviation		40.8	(5.92)	43.4	(6.29)	55.9	(8.11)	63.3	(9.18)		
TYS, MN/m^2 (ksi)	Avg	819	(119)	966	(140)	1317	(191)	1589	(230)		
	Min	765	(111)	938	(136)	1262	(183)	1510	(219)		
Std. Deviation		33.6	(4.87)	33.4	(4.84)	49.6	(7.19)	40.7	(5.90)		
Elong, percent	Avg	14.3		11.7		10.0		4.7			
	Min	11		7.5		9		1			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		12	(7)	7	(2)	7	(2)	12	(6)		
E, GN/m^2 (10^6 psi)	Avg	104	(15.1)	122	(17.7)	126	(18.3)	134	(19.4)		
	Min	101	(14.7)	112	(16.2)	118	(17.2)	128	(18.5)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1144	(166)	1248	(181)	1626	(236)	1448	(210)		
K_t = 6.3	Min	1041	(151)	1200	(174)	1606	(233)	1255	(182)		
No. of Spec. (No. of Heats)		11	(6)	7	(2)	8	(2)	12	(5)		
NTS, MN/m^2 (ksi)	Avg	952	(138)	1138	(165)	872	(126)	767	(111)		
K_t = 19+	Min	876	(127)	945	(137)	827	(120)	683	(99)		
No. of Spec. (No. of Heats)		7	(2)	5	(1)	5	(1)	8	(2)		

References: 40128, 48652, 50498, 59159, 70906

TABLE 9.2.1-ME1.1

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: 20% cold rolled

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	827 (120)			1634 (237)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	710 (103)			1365 (198)		
	Min						
Std. Deviation							
Elong, percent	Avg	8			6		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1014 (147)			1634 (237)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	827 (120)			1600 (232)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	674 (97.8)			1393 (202)		
	Min						
Std. Deviation							
Elong, percent	Avg	9			6		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1082 (157)			1820 (264)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90171

TABLE 9.2.1-ME1.2

Alloy Designation:	Ti-5Al-2.5Sn (Nominal Interstitial Content)
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	40% cold rolled

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	889 (127)			1641 (238)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	745 (108)			1427 (207)		
	Min						
Std. Deviation							
Elong, percent	Avg	7			4		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	924 (134)			1131 (164)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	889 (129)			1627 (236)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	8			9		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1117 (162)			1717 (249)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90171

TABLE 9.2.1-ME1.3

Alloy Designation:	Ti-5Al-2.5Sn (Nominal Interstitial Content)
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	50% cold rolled

Testing Temperature, K (F)		297 (75)			20 (423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	876 (127)			1579 (229)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	738 (107)			1400 (203)		
	Min						
Std. Deviation							
Elong, percent	Avg	5			1		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	814 (118)			986 (143)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	869 (126)			1613 (234)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	738 (107)			1462 (212)		
	Min						
Std. Deviation							
Elong, percent	Avg	8			9		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1096 (159)			1538 (223)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90171

TABLE 9.2.1-ME1.4

Alloy Designation:	**Ti-5Al-2.5Sn (Weld Metal)**
Specification:	
Form:	**Sheet-TIG welded, no filler**
Thickness, cm (in.):	**Up to 0.099 (0.039)**
Condition:	**Annealed**

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	816 (118.4)	1004 (145.6)		1320 (191.4)	1657.5 (240.4)	
	Min	765 (111.0)	1000 (145.0)		1241 (180.0)	1482.4 (215.0)	
Std. Deviation		33.8 (4.91)			66 (9.57)	139 (20.17)	
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	8.3	14.4		6.6	2.8	
	Min	1.0	12.5		1.5	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (3)	5 (1)		10 (1)	15 (3)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	818 (118.6)	978 (141.8)		1292 (187.4)	1573 (228.2)	
	Min	779 (113.0)	965 (140.0)		1186 (172.0)	1331 (193.0)	
Std. Deviation		18.75 (2.72)			83.1 (12.05)	143 (20.75)	
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	7.5	12.1		6.2	3.0	
	Min	1.0	11.0		0.5	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (1)	5 (1)		10 (1)	10 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 40128, 48652, 59159

TABLE 9.2.1-ME2

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	858 (124.4)	1118 (162)	1186 (172)	1400 (203)	1708 (247.8)	1620 (235)
	Min	793 (115)	1055 (153)		1276 (185)	1586 (230)	
Std. Deviation		56.3			106 (15.4)	95.5 (13.85)	
TYS, MN/m² (ksi)	Avg	804 (116.6)	1074 (156)	1165 (169)	1327 (192)	(23.54)	
	Min	710 (103)	1007 (146)		1186 (172)	1468 (213)	
Std. Deviation		68.7 (9.96)			126 (18.3)	(15.36)	
Elong, percent	Avg	16.28	11.7	9.3	13.6	7.82	1.3
	Min	10.80	7.3		4.6	2.00	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		25 (7)	7 (3)	3 (1)	21 (8)	31 (7)	3 (1)
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	1138 (165)	1386 (201)		1622 (235)	1382 (200)	
K_t = 6.3	Min	1076 (156)	1379 (200)		1586 (230)	1110 (161)	
No. of Spec. (No. of Heats)		15 (6)	2 (1)		15 (6)	21 ( )	
NTS, MN/m² (ksi)	Avg	1110 (161)	1193 (173)	1303 (189)	1186 (172)	1062 (154)	1007 (146)
K_t = 10	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	924 (134)	1089 (158)	1207 (175)	1469 (213)	1638 (238)	1593 (231)
	Min					1600 (232)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	903 (131)	1069 (155)	1200 (174)	1434 (208)	1635 (237)	
	Min						
Std. Deviation							
Elong, percent	Avg	14.3	11.5	10.7	13.2	6.3	1.5
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	4 (2)	3 (1)
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	1206 (175)				1131 (164)	
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		(1)				(1)	
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 29830, 33262, 40128, 45136, 46356, 50498, 58060, 59159, 90084

TABLE 9.2.1-ME2.1

Alloy Designation:	Ti-5Al-2.5Sn (Nominal Interstitial Content)
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	20% cold rolled

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1000 (145)			1889 (274)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	862 (125)			1682 (244)		
	Min						
Std. Deviation							
Elong, percent	Avg	9			4		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1303 (189)			1586 (230)		
K_t = 6.3	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90171

TABLE 9.2.1-ME2.2

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content) (Weld Metal)

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	834 (121)	976 (141.5)		1326 (192.3)	1644 (238.4)	
	Min	827 (120)	972 (141.0)		1310 (190.0)	1551 (225.0)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	12.3	11.0		8.0	3.7	
	Min	11.0	10.0		2.0	0.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	2 (1)		3 (1)	5 (2)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 40128, 59159

TABLE 9.2.1-ME2.3

Alloy Designation:	Ti-5Al-2.5Sn (Nominal Intersitial Content)
Specification:	
Form:	Plate
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	917 (133)		1438 (208.6)	1578 (228.8)		
	Min	914 (132.6)		1429 (207.3)	1577 (228.7)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	876 (127)		1358 (197)	1502 (217.8)		
	Min	875 (126.9)		1341 (194.5)	1485 (215.4)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	38.0		32.0	16.6		
	Min	32.8		31.7	12.4		
No. of Spec. (No. of Heats)		2 (1)		2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg				133 (19.3)		
	Min				132 (19.2)		
No. of Spec. (No. of Heats)					2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 91793

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TABLE 9.2.1-ME3

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	17 (-430)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	910 (132)	1088 (158)	1410 (204.5)	1774 (257)	1551 (225)	1475 (214)
	Min	862 (125)	1062 (154)	1344 (195)	1731 (251)	1469 (213)	1475 (214)
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	862 (125)	1032 (150)	1293 (187.5)	1721 (250)	1413 (205)	1413 (205)
	Min	827 (120)	1020 (148)	1096 (159)	1668 (242)	1379 (200)	1413 (205)
Std. Deviation							
Elong, percent	Avg	15.8	13.2	12.0	8.7	13.7	
	Min	12	12	10	3	12.0	
RA, percent	Avg	35.8	33	28.2	15	30	
	Min	25	27	22	17	21	
No. of Spec. (No. of Heats)		6 (3)	4 (2)	6 (3)	3 (2)	4 (1)	2 (1)
E, GN/m^2 (10^6 psi)	Avg	119 (17.3)		126 (18.3)			129 (18.7)
	Min	119 (17.3)		126 (18.3)			129 (18.7)
No. of Spec. (No. of Heats)		2 (1)		2 (1)			2 (1)
Poisson's Ratio		0.289		0.287			0.287
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 78652, 89543

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TABLE 9.2.1-ME4

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content

Specification:
Form: Bar
Diameter: Up to 2.540 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)			
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear[a]										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., J(ft-lb)	Avg	23.9	(17.6)	19.4	(14.3)	15.2	(11.2)			
	Min	23.7	(17.5)	18.3	(13.5)	14.2	(10.5)			
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)			
Trans., J(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness[b]										
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg									
	Min									
Orientation –										
No. of Spec. (No. of Heats)										
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{}$in.)	Avg									
(From PTSC spec.)(–)	Min									
No. of Spec. (No. of Heats)										

References: 54986

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

69[illegible]

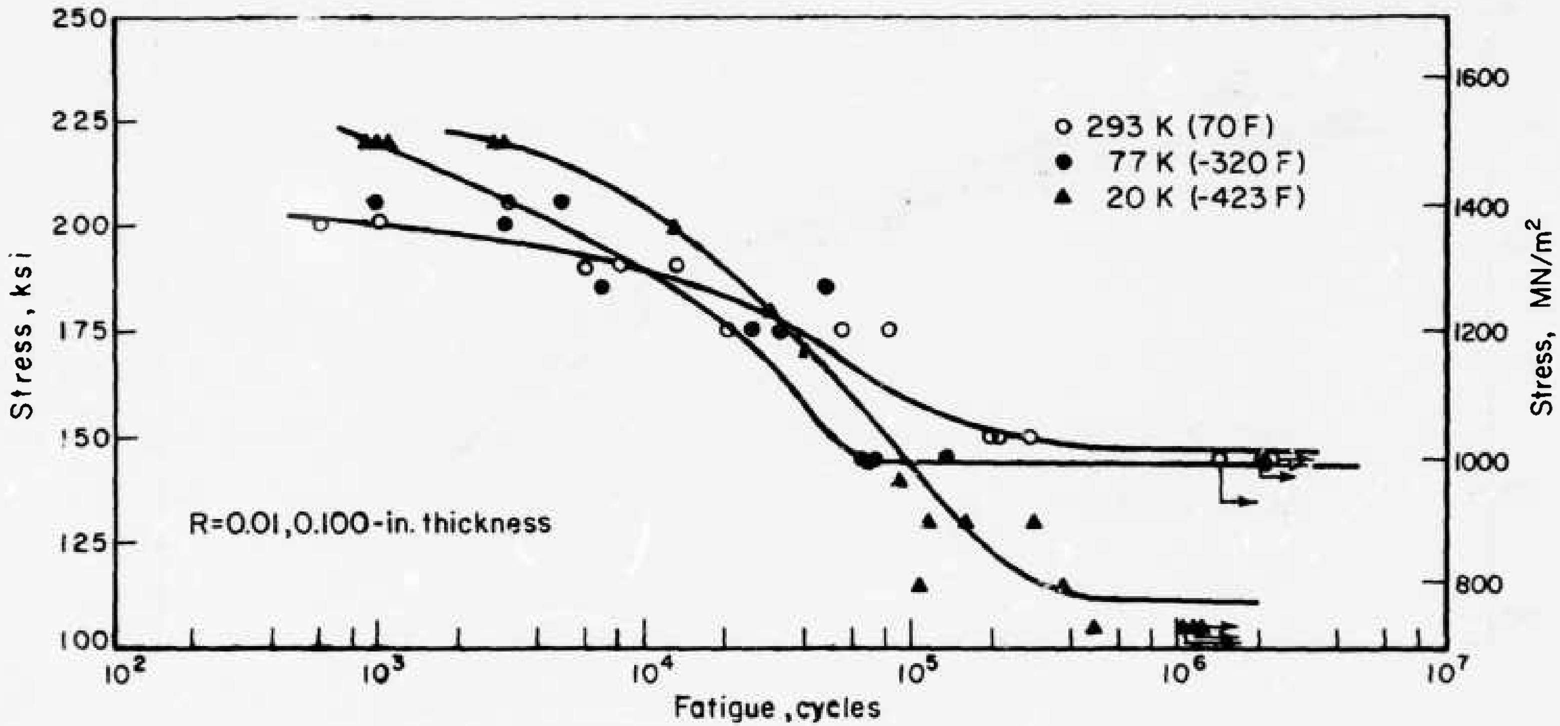

FIGURE 9.2.1-ME8. AXIAL FATIGUE LIFE CURVES FOR UNNOTCHED 5Al-2.5Sn (ANNEALED) TITANIUM ALLOY [58024]

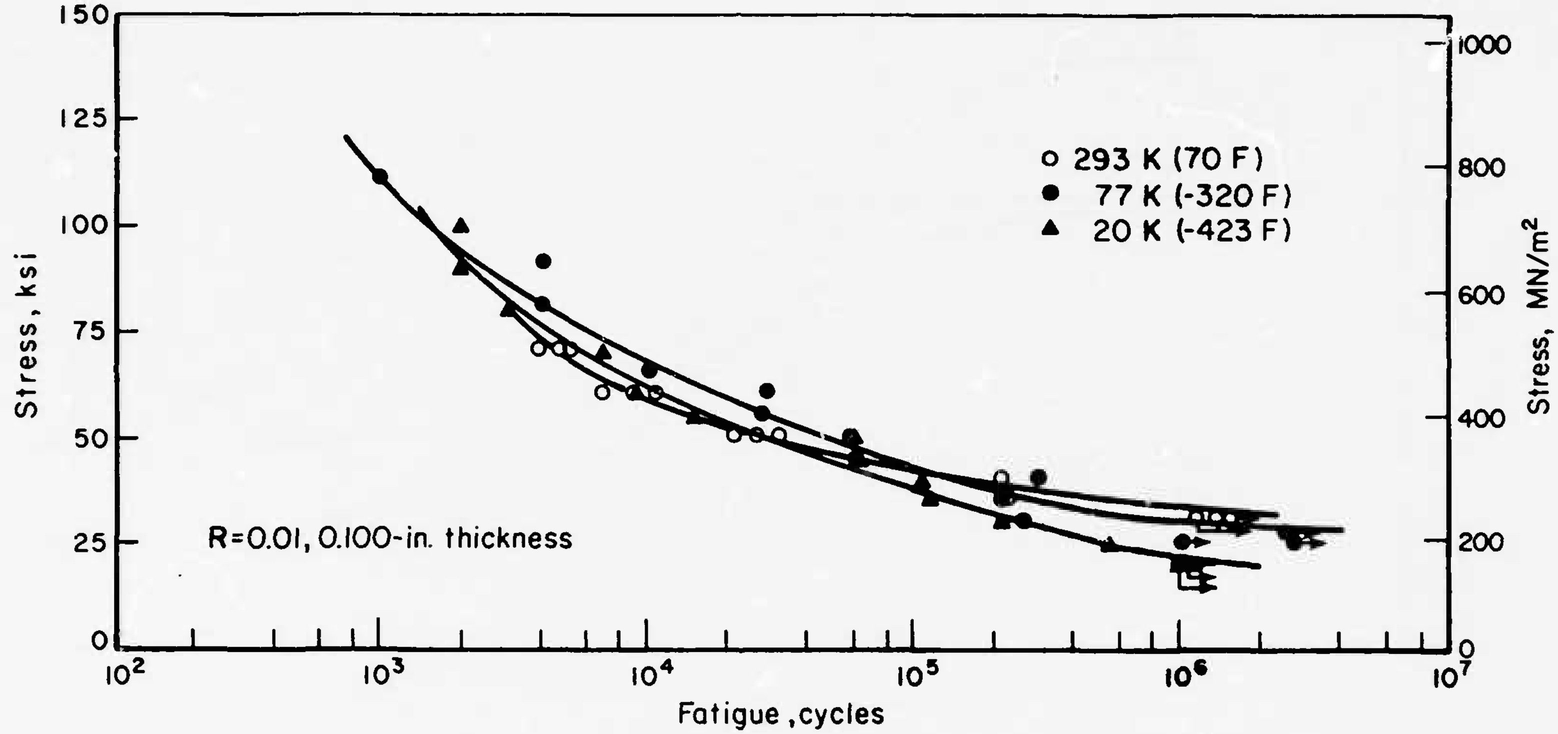

FIGURE 9.2.1-ME9. AXIAL FATIGUE LIFE CURVES FOR NOTCHED 5Al-2.5Sn (ANNEALED) TITANIUM ALLOY [58024]

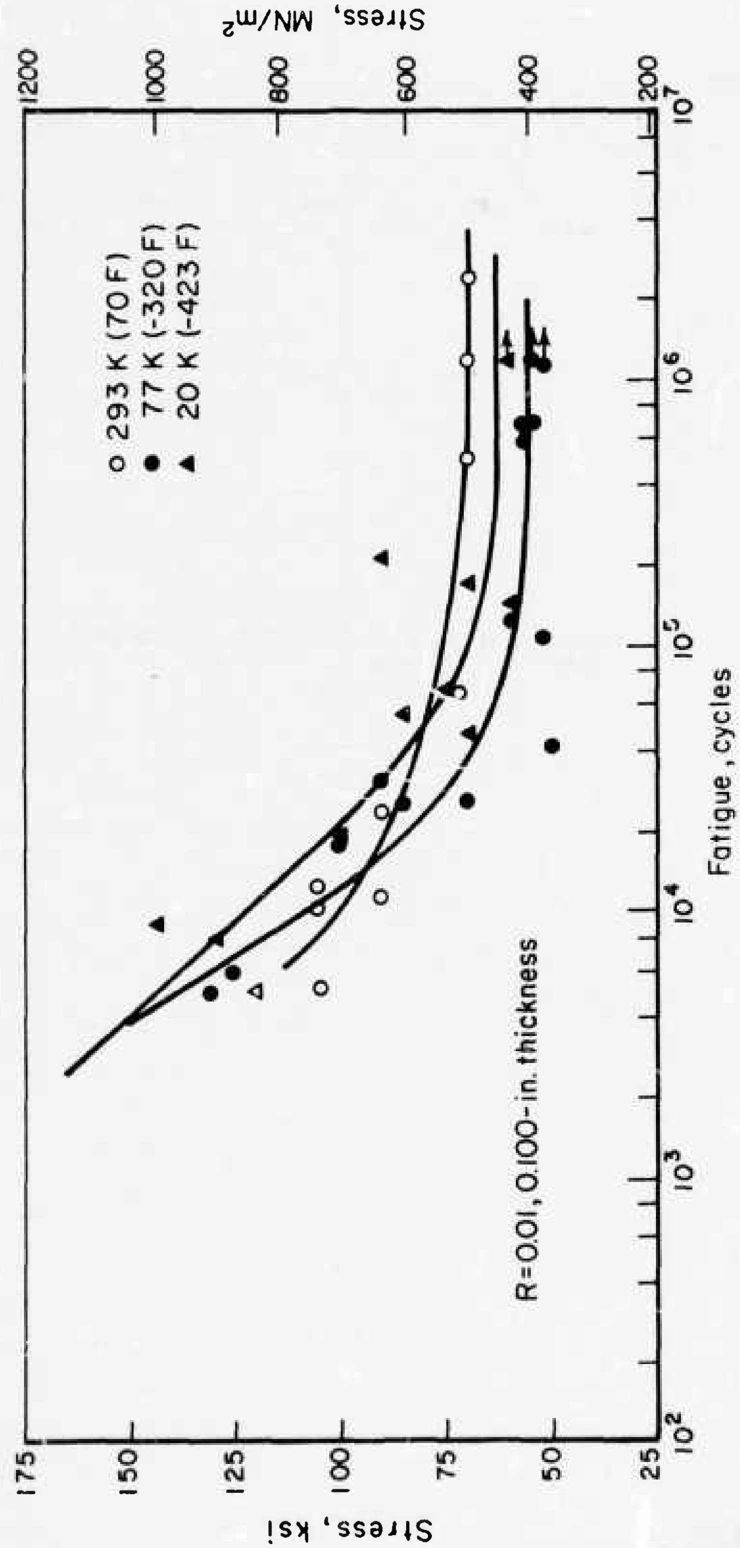

FIGURE 9.2.1-ME10. AXIAL FATIGUE LIFE CURVES FOR 5Al-2.5Sn (ANNEALED) TITANIUM ALLOY SHEET AS WELDED [TIG welded; parent metal filler] [58024]

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TABLE 9.2.1-TR1

Alloy Designation: Ti-5Al-2.5Sn Alloy

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	7.79		4.83		3.59		1.95		0.996			
Btu hr^{-1} ft^{-1} F^{-1}		(4.50)		(2.79)		(2.08)		(1.13)		(0.576)		
No. of Spec.	1		1		1		1		1			
References: 96885												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.128		-0.147		-0.152		-0.152		-0.153	
No. of Spec.	3		3		3		2		1		1	
References: 94206												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m	161×10^{-8}		142×10^{-8}		137×10^{-8}		136×10^{-8}		136×10^{-8}		136×10^{-8}	
Ohm circular mil ft^{-1}		(968)		(854)		(824)		(818)		(818)		(818)
No. of Spec.	2		2		2		2		2		2	
References: 96885												

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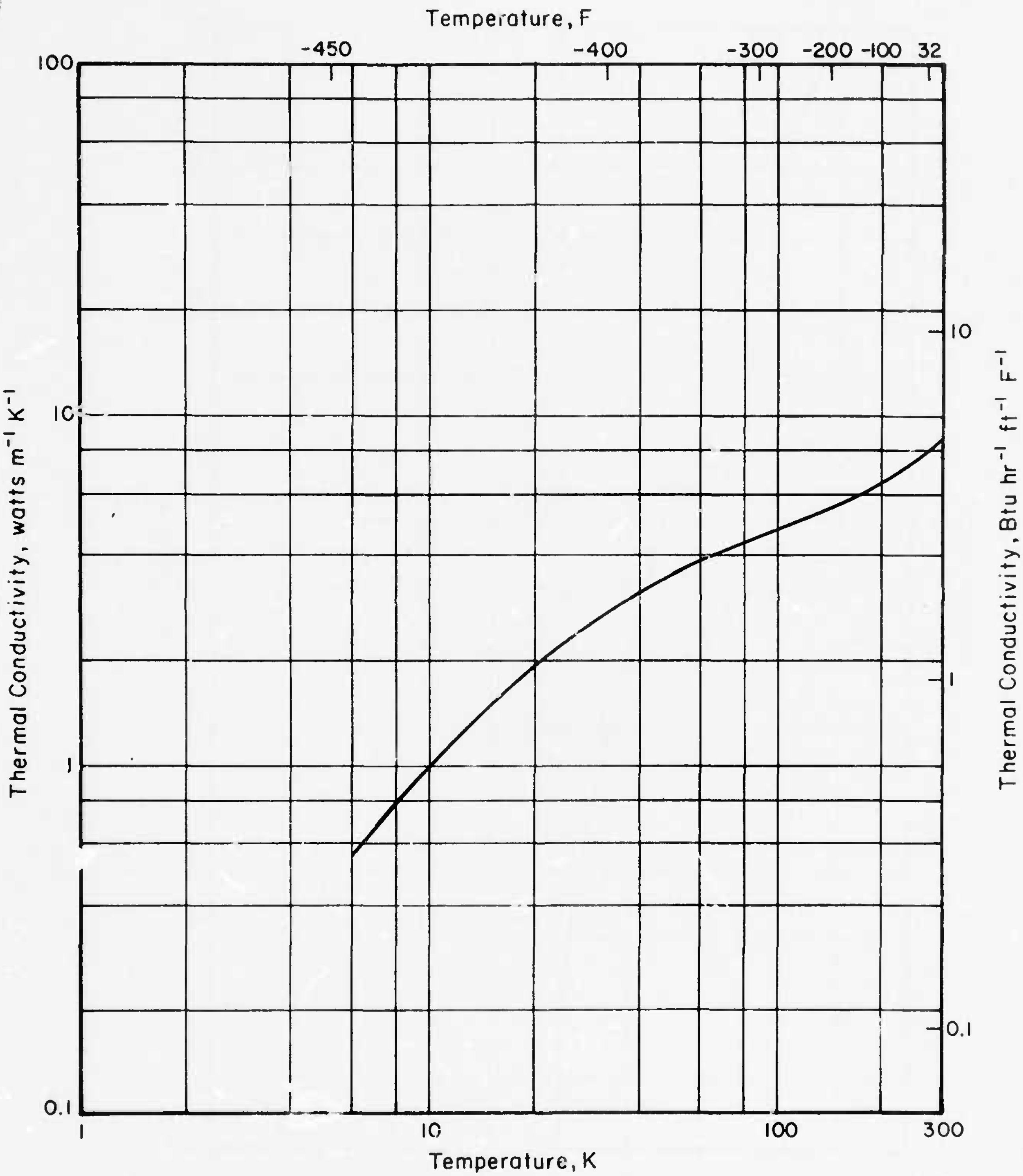

FIGURE 9.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Ti-5Al-2.5Sn ALLOY

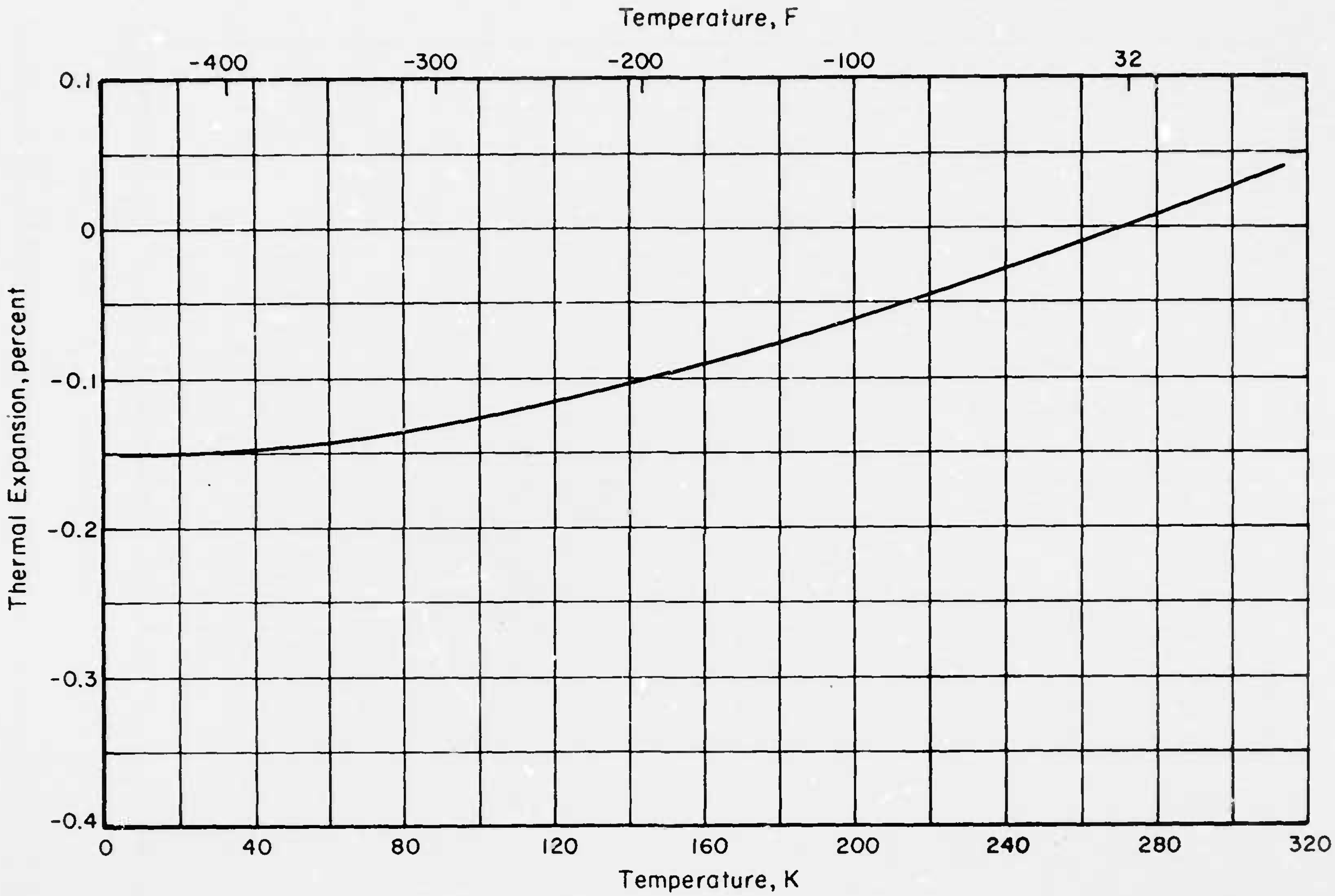

FIGURE 9.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Ti-5Al-2.5Sn ALLOY

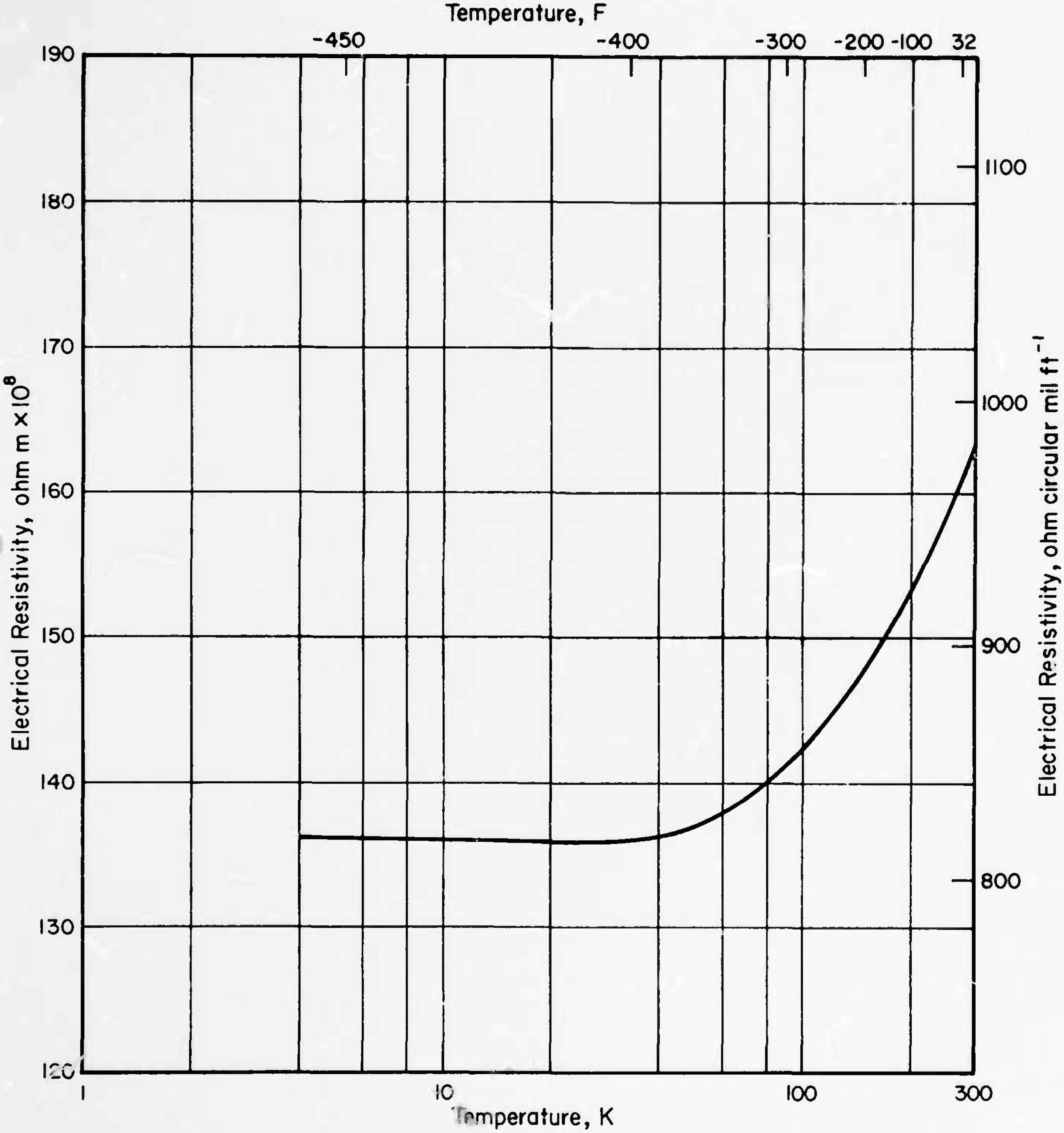

FIGURE 9.2.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR Ti-5Al-2.5Sn ALLOY

TABLE 9.2.2-ME1

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	779	(113)	933	(135)	1276	(185)	1537	(223)		
	Min	654	(94.9)	889	(129)	1227	(178)	1363	(198)		
Std. Deviation		55.8	(8.10)			31.8	(4.62)	80.6	(11.7)		
TYS, MN/m^2 (ksi)	Avg	721	(105)	855	(124)	1186	(172)	1429	(207)		
	Min	652	(94.6)	807	(117)	1117	(162)	1317	(191)		
Std. Deviation		53.6	(7.78)			30.1	(4.37)	76.2	(11.1)		
Elong, percent	Avg	16.6		14.3		15.8		10.6			
	Min	12		11		10		nil			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		41	(16)	3	(3)	21	(7)	46	(16)		
E, GN/m^2 (10^6 psi)	Avg	111	(16.1)			127	(18.5)	131	(19.0)		
	Min	108	(15.7)			123	(17.8)	118	(17.1)		
No. of Spec. (No. of Heats)		7	(2)			10	(2)	11	(2)		
Poisson's Ratio		0.416				0.364		0.328			
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1031	(150)	1156	(168)	1549	(225)	1691	(245)		
K_t = 6.3	Min	869	(126)	1096	(159)	1441	(209)	1413	(205)		
No. of Spec. (No. of Heats)		26	(11)	3	(3)	7	(5)	26	(11)		
NTS, MN/m^2 (ksi)	Avg	820	(119)					900	(131)		
K_t = 19	Min										
No. of Spec. (No. of Heats)		1	(1)					3	(1)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	799	(116)	926	(134)	1288	(187)	1566	(227)		
	Min	654	(94.9)	896	(130)	1220	(177)	1441	(209)		
Std. Deviation		60.4	(8.76)			37.5	(5.44)	60.2	(8.73)		
TYS, MN/m^2 (ksi)	Avg	749	(109)	857	(124)	1226	(178)	1471	(213)		
	Min	637	(92.4)	827	(120)	1138	(165)	1310	(190)		
Std. Deviation		64.3	(9.33)			46.8	(6.79)	75.8	(11.0)		
Elong, percent	Avg	15.3		14.7		16.8		9.4			
	Min	13.5		12		16		2			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		18	(10)	3	(3)	8	(4)	19	(10)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1090	(158)	1220	(177)	1620	(235)	1627	(236)		
K_t = 6.3	Min	876	(127)	1179	(171)	1538	(223)	1434	(208)		
No. of Spec. (No. of Heats)		11	(7)	3	(3)	5	(4)	11	(7)		
NTS, MN/m^2 (ksi)	Avg	810	(118)					869	(126)		
K_t = 19	Min	807	(117)					800	(116)		
No. of Spec. (No. of Heats)		2	(1)					3	(1)		

References: 45136, 48652, 50498, 53354, 59159, 66103, 66886, 68968, 69759

TABLE 9.2.2-ME1.1

Alloy Designation:	Ti-5Al-2.5Sn(ELI) (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, no filler
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	733.6 (106.4)			1262 (183)	1528 (221.6)	
	Min	643.3 (93.3)			1262 (183)	1386 (201.0)	
Std. Deviation		46.3 (6.71)				76.7 (11.13)	
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	13.4			2.0	2.65	
	Min	1.7			2.0	0.00	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		11 (3)			1 (1)	35 (3)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	807 (117)			1234 (179)	1475.5 (214)	
	Min	807 (117)			1234 (179)	1475.5 (214)	
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6			1.6	1.0	
	Min	1.6			1.6	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)	1 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 53354, 59159, 60578

TABLE 9.2.2-ME2

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)
Tension, Longitudinal									
TUS, MN/m^2 (ksi)	Avg	812	(118)	985	(143)	1313	(190)	1599	(232)
	Min	758	(110)	910	(132)	1234	(179)	1429	(207)
Std. Deviation		41.6	(6.03)	69.6	(10.1)	53.2	(7.72)	91.7	(13.3)
TYS, MN/m^2 (ksi)	Avg	752	(109)	905	(131)	1230	(178)	1475	(214)
	Min	696	(101)	814	(118)	1158	(168)	1331	(193)
Std. Deviation		37.9	(5.50)	56.8	(8.24)	55.9	(8.11)	91.7	(13.3)
Elong, percent	Avg	15.5		14.8		15.4		9.5	
	Min	6.5		5.5		3.0		1.5	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		24	(10)	7	(4)	25	(11)	29	(11)
E, GN/m^2 (10^6 psi)	Avg	114	(16.6)	124	(18.0)	129	(18.8)	134	(19.4)
	Min	108	(15.7)	124	(18.0)	120	(17.4)	131	(19.0)
No. of Spec. (No. of Heats)		10	(5)	2	(1)	10	(4)	5	(2)
Poisson's Ratio		0.32		0.285		0.31		0.34	
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg	1089	(158)			1613	(234)	1769	(257)
K_t = 3.5	Min	1089	(158)			1551	(225)	1[illegible]65	(227)
No. of Spec. (No. of Heats)		3	(1)			3	(1)	3	(1)
NTS, MN/m^2 (ksi)	Avg	1076	(156)	1227	(178)	1567	(227)	1640	(238)
K_t = 6.3	Min	1048	(152)	1200	(174)	1531	(222)	1372	(199)
No. of Spec. (No. of Heats)		11	(5)	5	(3)	11	(5)	14	(6)
Tension, Transverse									
TUS, MN/m^2 (ksi)	Avg	817	(118)	986	(143)	1308	(190)	1576	(228)
	Min	758	(110)	910	(132)	1326	(179)	1402	(203)
Std. Deviation		52.3	(7.59)			64.2	(9.31)	133	(19.4)
TYS, MN/m^2 (ksi)	Avg	776	(112)	936	(136)	1244	(180)	1473	(214)
	Min	703	(102)	896	(130)	1189	(172)	1386	(201)
Std. Deviation		44.4	(6.44)			52.2	(7.57)	82.7	(12.0)
Elong, percent	Avg	12.2		9.1		12.2		8.1	
	Min	6.5		5.5		1.5		1.5	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		9	(6)	6	(4)	9	(6)	10	(5)
E, GN/m^2 (10^6 psi)	Avg	110	(16.0)	127	(18.4)	125	(18.1)	138	(20.1)
	Min	107	(15.5)	127	(18.4)	117	(17.0)	135	(19.6)
No. of Spec. (No. of Heats)		4	(2)	2	(1)	4	(2)	2	(1)
Poisson's Ratio		0.305		0.305		0.275		0.315	
Work Hardening Coef									
NTS, MN/m^2 (ksi)	Avg	1105	(160)	1300	(188)	1529	(222)	1439	(209)
K_t = 6.3	Min	1089	(158)	1289	(187)	1462	(212)	1220	(177)
No. of Spec. (No. of Heats)		3	(1)	2	(2)	4	(3)	4	(3)
NTS, MN/m^2 (ksi)	Avg								
K_t =	Min								
No. of Spec. (No. of Heats)									

References: 40128, 45136, 46356, 50498, 58024, 61688, 80104, 81726, 84318, 87195

TABLE 9.2.2-ME3

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m^2(ksi)	586 (85)		827 (120)	965 (140)		
Loading frequency Hz						
with R = 0.01 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.73		0.65	0.60		
S_N at 10^6 cycles, MN/m^2(ksi)	483 (70)		827 (120)	882 (128)		
Loading frequency Hz						
with R = 0.01 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.60		0.65	0.55		
S_N at 10^6 cycles, MN/m^2(ksi)	496 (72)		814 (118)	758 (110)		
Loading frequency Hz						
with R = 0.01 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.62		0.62	0.48		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 53308, 56753, 58024

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TABLE 9.2.2-ME3.1

Alloy Designation: Ti-5Al-2.5Sn (ELI) (Weld Metal)

Specification:
Form: Sheet-TIG welded, Ti-5Al-2.5Sn filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)	
Tension, Longitudinal												
TUS, MN/m^2 (ksi)	Avg	820	(119.0)	1086	(157.5)	1314	(190.6)	1595	(231.3)	1627	(236.0)	
	Min	770	(111.7)	1086	(157.5)	1252	(181.6)	1495	(216.9)	1627	(236.0)	
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	905	(131.2)	1047	(151.9)	1444	(209.5)	1649	(239.2)			
	Min	905	(131.2)	1047	(151.9)	1444	(209.5)	1649	(239.2)			
Std. Deviation												
Elong, percent	Avg	11.0		10.0		10.0		6.2		1.5		
	Min	11.0		10.0		10.0		6.2		1.5		
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		4	(2)	1	(1)	4	(2)	4	(2)	1	(1)	
E, GN/m^2 (10^6 psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m^2 (ksi)	Avg	789	(114.5)			1262	(183.0)	1377	(199.7)			
	Min	776	(112.5)			1247	(180.9)	1338	(194.1)			
Std. Deviation												
TYS, MN/m^2 (ksi)	Avg	736	(106.8)			1187	(172.2)					
	Min	722	(104.8)			1178	(170.9)					
Std. Deviation												
Elong, percent	Avg	7.0				9.0						
	Min	6.0				8.0						
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)		2	(1)			3	(1)	2	(1)			
E, GN/m^2 (10^6 psi)	Avg	112.4	(16.3)			123.4	(17.9)					
	Min	111.0	(16.1)			117.9	(17.1)					
No. of Spec. (No. of Heats)		2	(1)			3	(1)					
Poisson's Ratio		0.350				0.340		0.340				
Work Hardening Coef												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
No. of Spec. (No. of Heats)												

References: 56024, 58060, 84318

TABLE 9.2.2-ME3.2

Alloy Designation: Ti-5Al-2.5SN (ELI)(Weld Metal)

Specification:
Form: Sheet-TIG welded, no filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297	(75)		77	(-320)	20	(-423)		
Tension, Longitudinal										
TUS, MN/m^2 (ksi)	Avg	852	(123.6)		1338	(194.1)	1612	(233.8)		
	Min	805	(116.8)		1305	(189.3)	1593	(231.0)		
Std Deviation		37.3	(5.41)		25.2	(3.66)				
TYS, MN/m^2 (ksi)	Avg	767	(111.2)		1241	(180)	1457	(211.3)		
	Min	731	(106.0)		1227	(178)	1420	(206.0)		
Std Deviation		22.5	(3.27)		12.4	(1.80)				
Elong, percent	Avg	16.1			5.2					
	Min	16.1			5.2					
RA, percent	Avg	44.0			13.0					
	Min	44.0			13.0					
No. of Spec. (No. of Heats)		9	(2)		9	(2)	6	(1)		
E, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Poisson's Ratio										
Work Hardening Coef										
NTS, MN/m^2 (ksi)	Avg	896	(130)		1372	(199)				
K_t = 6	Min	896	(130)		1372	(199)				
No. of Spec. (No. of Heats)		3	(1)		3	(1)				
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										
Tension, Transverse										
TUS, MN/m^2 (ksi)	Avg									
	Min									
Std Deviation										
TYS, MN/m^2 (ksi)	Avg									
	Min									
Std Deviation										
Elong, percent	Avg									
	Min									
RA, percent	Avg									
	Min									
No. of Spec. (No. of Heats)										
E, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Poisson's Ratio										
Work Hardening Coef										
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										
NTS, MN/m^2 (ksi)	Avg									
K_t =	Min									
No. of Spec. (No. of Heats)										

References: 77998, 81726

TABLE 9.2.2-ME4

Alloy Designation:	Ti-5Al-2.5Sn (ELI)
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.320 to 0.634 (0.126 to 0.249)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	807 (117)		1317 (191)	1519 (220)		
	Min	786 (114)		1289 (187)	1434 (208)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	764 (111)		1241 (180)	1459 (212)		
	Min	758 (110)		1227 (178)	1420 (206)		
Std. Deviation							
Elong, percent	Avg	16.5		15.6	5.7		
	Min	15		12	4		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)		7 (4)	8 (4)		
E, GN/m^2 (10^6 psi)	Avg	110 (16.0)		121 (17.6)			
	Min	110 (16.0)		120 (17.4)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio		0.33		0.36	0.42		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	798 (116)		1280 (186)	1419 (206)		
	Min	793 (115)		1280 (186)	1400 (203)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	779 (113)		1227 (178)	1391 (202)		
	Min	779 (113)		1227 (178)	1377 (200)		
Std. Deviation							
Elong, percent	Avg	17		15			
	Min	17		15			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg	108 (15.7)		128 (18.6)			
	Min	108 (15.7)		126 (18.3)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 66218, 84318, 84320, 86296

TABLE 9.2.2-ME5

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Sheet
Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)
Condition: Annealed

Testing Temperature, K (F)		297 (75)			20 (-423)		
Compression, Longitudinal							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m^2 (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg						
	Min						
Orientation —							
No. of Spec. (No. of Heats)							
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg				56.9 (52.1)		
(From PTSC spec.)(L – S)	Min				51.8 (47.4)		
No. of Spec. (No. of Heats)					3 (1)		

References: 84320

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 9.2.2-ME5.1

Alloy Designation:	Ti-5Al-2.5SN(ELI) (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, Ti-5Al-2.5Sn filler
Thickness, cm (in.):	0.320 to 0.634 (0.126 to 0.249)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	807 (117.1)		1277 (185.2)	1414 (205.1)		
	Min	804 (116.6)		1277 (185.2)	1393 (202.1)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	764 (110.8)		1215 (176.3)			
	Min	764 (110.8)		1215 (176.3)			
Std. Deviation							
Elong, percent	Avg	11.5		11.0			
	Min	11.0		10.0			
RA, percent	Avg	39		22	21		
	Min	37		20	21		
No. of Spec. (No. of Heats)		2 (1)		2 (1)	2 (1)		
E, GN/m^2 (10^6 psi)	Avg	126 (18.3)		130 (18.8)			
	Min	123 (17.9)		128 (18.6)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio		0.270		0.260	0.250		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 84313

TABLE 9.2.2-ME6

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	820	(118.9)	910	(132)	1280	(185.6)	1506	(218.4)		
	Min	789	(114.5)			1220	(177)	1441	(209)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	754	(109.4)	869	(126)	1199	(174)	1375	(199.4)		
	Min	689	(100)			1175	(170.5)	1344	(195)		
Std. Deviation		--				31.8	(4.62)	41.9	(6.08)		
Elong, percent	Avg	18.7		24		12.4		8.1			
	Min	14				8		5			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		7	(4)		(1)	7	(4)	7	(4)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef		0.076		0.058							
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	809	(117)	912	(132)	1261	(183)	1473	(214)		
	Min	786	(114)	903	(131)	1251	(181)	1400	(203)		
Std. Deviation											
TYS, MN/m^2 (ksi)	Avg	740	(107)	884	(128)	1203	(174)	1310	(190)		
	Min	706	(102)	869	(126)			1248	(181)		
Std. Deviation											
Elong, percent	Avg	21.3		21.8		23.4		21.4			
	Min	15.5		21.3		22.7		17.1			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		3	(2)	2	(1)	8	(2)	6	(3)		
E, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef		0.063		0.037							
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 56755, 64969, 79816, 80996, 84321, 96685

TABLE 9.2.2-ME7

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification: MIL-T-9046 C, Class 3
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Compression, Longitudinal											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Compression, Transverse											
CYS, MN/m^2 (ksi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Ec, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Shear[(a)]											
SUS, MN/m^2 (ksi)	Avg	594	(86.1)	758	(110)	979	(142)	903	(131)		
Transverse Specimens	Min										
No. of Spec. (No. of Heats)		4	(1)	4	(1)	4	(1)	4	(1)		
G, GN/m^2 (10^6 psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Impact, Charpy V											
Long., Nm(ft-lb)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Trans., Nm(ft-lb)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Fracture Toughness[(b)]											
K_{Ic} MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg										
	Min										
Orientation: —											
No. of Spec. (No. of Heats)											
K_{IE}, MN/m$^{3/2}$(ksi$\sqrt{}$in.)	Avg										
(From PTSC spec.)(—)	Min										
No. of Spec. (No. of Heats)											

References: 65182

(a) Indicate specimen design and orientation for shear specimens: 0.394 cm (0.155 in.) diameter
(b) Indicate specimen design for K_{Ic} data:

TABLE 9.2.2-ME7.1

Alloy Designation:	Ti-5Al-2.5SN(ELI)(Weld Metal)
Specification:	
Form:	Plate-TIG welded, no filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	869 (126)		1324 (192)	1551 (225.0)		
	Min	869 (126)		1324 (192)	1529 (221.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	807 (117)		1269 (184)	1406 (204)		
	Min	807 (117)		1269 (184)	1406 (204)		
Std. Deviation							
Elong, percent	Avg	11.0		9.0	7.4		
	Min	11.0		9.0	6.2		
RA, percent	Avg				24.6		
	Min				21.1		
No. of Spec. (No. of Heats)		1 (1)		1 (1)	3 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 76455, 84321

TABLE 9.2.2-ME8

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	765 (111)	905 (131)	1247 (180.8)	1438 (208.5)		
	Min	745 (108)	889 (129)	1213 (176)	1386 (201)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	702 (101.8)	859 (124)	1204 (174.7)	1389 (201.5)		
	Min	683 (99)	854 (124)	1176 (170.6)	1289 (187)		
Std. Deviation				12 (1.76)	46 (6.68)		
Elong, percent	Avg	32.8	22.4	26.0	17.0		
	Min	14.0	22.2	8.0	3.0		
RA, percent	Avg	43.2	40.4	35.8	31.6		
	Min	42.6	38.7	34.8	31.2		
No. of Spec. (No. of Heats)		5 (3)	2 (1)	5 (3)	5 (3)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef		0.067	0.049	0.060			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	776 (112)	906 (131)	1234 (179)	1542 (224)		
	Min	776 (112)	887 (129)	1230 (178)	1513 (219)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	696 (101)	855 (124)	1203 (174.5)	1420 (206)		
	Min	696 (101)		1165 (169)	1400 (203)		
Std. Deviation				13.4 (1.95)	21.5 (3.12)		
Elong, percent	Avg	24.6	20.6	21.4	17.8		
	Min	23.1	20	20			
RA, percent	Avg	42.8	39.6	36.8	31.5		
	Min	41.9	38.7	36.5	31.2		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	13 (2)	15 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef		0.062	0.054				
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64969, 84321, 91793, 96685

TABLE 9.2.2-ME8.1

Alloy Designation:	Ti-5Al-2.5Sn(ELI)(Weld Metal)
Specification:	
Form:	Plate-TIG welded, no filler
Thickness, cm (in.):	1.270 to 2.540 (0.500 to 1.000)
Condition:	Tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	809 (117.3)		1158 (168.0)	1481 (214.8)		
	Min	809 (117.3)		1149 (166.7)	1481 (214.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	717 (104)		1027 (149)			
	Min	717 (104)		993 (144)			
Std. Deviation							
Elong, percent	Avg	15.8		12.1	8.0		
	Min	15.8		12.0	8.0		
RA, percent	Avg	16.3		17.4	32.4		
	Min	16.3		17.4	32.4		
No. of Spec. (No. of Heats)		1 (1)		2 (1)	1 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 76455

TABLE 9.2.2-ME9

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)	17 (-430)	4 (-452)
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	878 (127)		1376 (200)	1531 (222)	1575 (228.4)	1476 (214)
	Min	814 (118)		1317 (191)	1503 (218)	1538 (223)	
Std. Deviation		30.1 (4.36)		57.7 (8.37)		33.6 (4.88)	
TYS, MN/m^2 (ksi)	Avg	814 (118)		1260 (183)	1455 (211)	1477 (214.2)	1413 (205)
	Min	717 (104)		1096 (159)	1427 (207)	1400 (203)	
Std. Deviation		37.1 (5.38)		128 (18.6)		51.7 (7.5)	
Elong, percent	Avg	15.8		12.2	5.7	9.7	
	Min	12		8	3	[illegible]	
RA, percent	Avg	42.2				32.3	
	Min	39				32	
No. of Spec. (No. of Heats)		14 (4)		9 (3)	3 (1)	10 (2)	3 (1)
E, GN/m^2 (10^6 psi)	Avg	119 (17.3)		126 (18.3)			129 (18.7)
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)			3 (1)
Poisson's Ratio		0.289		0.287			0.287
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1058 (153)				1842 (267)	
K_t = 6.4	Min	1000 (145)				1800 (261)	
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64373, 83417, 89543

TABLE 9.2.2-ME10

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:
Form: Bar
Thickness, cm (in.): Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading, Surface Finish 32 rms						
S_N at 10^5 cycles, MN/m^2(ksi)	807 (117)		1207 (175)	1076 (156)		
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.92		0.91	0.70		
S_N at 10^6 cycles, MN/m^2(ksi)	758 (110)		986 (143)	924 (134)		
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.87		0.74	0.60		
S_N at 10^7 cycles, MN/m^2(ksi)	717 (104)		882 (128)			
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.82		0.66			
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m^2(ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 83417

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TABLE 9.3.1-ME1

Alloy Designation: Ti-6Al-4V (ELI)

Specification:
Form: Sheet
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Annealed

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	958	(139)	1165	(169)	1489	(216)	1744	(253)		
	Min	855	(124)	1131	(164)	1351	(196)	1531	(222)		
Std. Deviation		54	(7.85)			67	(9.73)	91	(13.2)		
TYS, MN/m^2 (ksi)	Avg	889	(129)	1118	(162)	1393	(202)	1682	(244)		
	Min	827	(120)	1117	(162)	1207	(175)	1462	(212)		
Std. Deviation		49	(7.07)			114	(16.47)	79	(11.40)		
Elong, percent	Avg	12.14		10.5		10.75		6.20			
	Min	10		7		5		1			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		[illegible]	(3)	5	(1)	13	(3)	14	(4)		
E, GN/m^2 (10^6 psi)	Avg	110	(16.0)	115	(16.7)	119	(17.3)	132	(19.1)		
	Min	109	(15.8)	111	(16.1)	114	(16.5)	128	(18.6)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1131	(164)	1291	(187)	1517	(220)	1689	(245)		
K_t = 6.3	Min	1020	(148)	1248	(181)	1462	(212)	1386	(201)		
No. of Spec. (No. of Heats)		7	(2)	5	(1)	7	(2)	7	(2)		
NTS, MN/m^2 (ksi)	Avg	945	(137)	814	(118)	889	(129)	855	(124)		
K_t = 19	Min	869	(126)	724	(105)	807	(117)	807	(117)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	912	(132)	1129	(164)	1472	(214)	1763	(256)		
	Min	814	(118)	1123	(163)	1379	(200)	1627	(236)		
Std. Deviation								100	(14.5)		
TYS, MN/m^2 (ksi)	Avg	857	(124)	1064	(154)	1428	(207)	1715	(249)		
	Min	800	(116)	1054	(153)	1331	(193)	1613	(234)		
Std. Deviation											
Elong, percent	Avg	13.1		13.7		12.6		6.1			
	Min	12.5		12.5		7.5		2			
RA, percent	Avg										
	Min										
No. of Spec. (No. of Heats)		7	(2)	5	(1)	7	(2)	9	(2)		
E, GN/m^2 (10^6 psi)	Avg	108	(15.7)	111	(16.1)	118	(17.2)	131	(19.1)		
	Min	105	(15.3)	109	(15.8)	114	(16.5)	126	(18.3)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1094	(159)	1247	(181)	1488	(216)	1845	(268)		
K_t = 6.3	Min	1082	(157)	1241	(180)	1393	(202)	1813	(263)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		
NTS, MN/m^2 (ksi)	Avg	841	(122)	809	(117)	1000	(145)	793	(115)		
K_t = 19	Min	786	(114)	807	(117)	979	(142)	745	(108)		
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)		

References: 47125, 51527, 90185

TABLE 9.3.1-ME2

Alloy Designation: Ti-6Al-4V (ELI)

Specification:
Form: Sheet
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)
Tension, Longitudinal						
TUS, MN/m^2 (ksi)	Avg	958 (138.9)	1144 (165.9)	1324 (192)	1506 (218.5)	1779 (258)
	Min	896 (130)	1107 (160.5)		1482 (215)	1717 (249)
Std. Deviation		40.7 (5.9)	--		12 (1.72)	34.4 (4.99)
TYS, MN/m^2 (ksi)	Avg	889 (128.9)	1082 (157)		1448 (210)	1717 (249)
	Min	841 (122)	1053 (152.8)		1393 (202)	1648 (239)
Std. Deviation		35 (5.09)	--		34 (4.97)	41.4 (6.0)
Elong, percent	Avg	11.28	8.17	8	9.50	2.98
	Min	7	2.5		2	1.7
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		9 (5)	6 (4)	(1)	10 (5)	9 (4)
E, GN/m^2 (10^6 psi)	Avg	112.4 (16.3)	113 (16.4)		122 (17.7)	124 (18.0)
	Min	108.9 (15.8)	112.4 (16.3)		119 (17.3)	118.6 (17.2)
No. of Spec. (No. of Heats)		2 (1)	2 (1)		3 (1)	3 (1)
Poisson's Ratio		0.21	0.24		0.20	0.18
Work Hardening Coef						
NTS, MN/m^2 (ksi)	Avg	1105 (160.3)	1151 (167)		1400 (203)	1303 (189)
K_t = 6.3	Min	1082 (157)	1131 (164)		1248 (181)	1117 (162)
No. of Spec. (No. of Heats)		6 (3)	3 (2)		6 (3)	6 (3)
NTS, MN/m^2 (ksi)	Avg	1048 (152)	1138 (165)	1202 (177)	1193 (173)	
K_t = 10 - 11.2	Min					
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	
Tension, Transverse						
TUS, MN/m^2 (ksi)	Avg	1004 (145.6)	1198 (173.7)		1522 (220.7)	1735 (251.6)
	Min	938 (136)	1158 (168)		1475 (214)	1599 (232)
Std. Deviation						
TYS, MN/m^2 (ksi)	Avg	944 (137)	1149 (166.6)		1491 (216.3)	1682 (244)
	Min	882 (128)	1103 (160)		1448 (210)	1586 (230)
Std. Deviation						
Elong, percent	Avg	12.2	10.9		10	1.94
	Min	10	10		5	1
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		5 (2)	5 (3)		7 (3)	7 (3)
E, GN/m^2 (10^6 psi)	Avg	112 (16.3)	116 (16.8)		133 (19.3)	134 (19.4)
	Min	109.6 (15.9)	113 (16.4)		120 (17.4)	127 (18.4)
No. of Spec. (No. of Heats)		2 (1)	3 (1)		3 (1)	3 (1)
Poisson's Ratio		0.27	0.25		0.24	0.20
Work Hardening Coef						
NTS, MN/m^2 (ksi)	Avg	1165 (169)	1273 (184.7)		1389 (201.5)	1255 (182)
K_t = 6.3	Min	1158 (168)	1248 (181)		1255 (182)	1158 (168)
No. of Spec. (No. of Heats)		4 (2)	3 (2)		4 (2)	4 (2)
NTS, MN/m^2 (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						

References: 40128, 47334, 49225, [illegible]9800, 90185

TABLE 9.3.1-ME2.1

Alloy Designation:	Ti-6Al-4V(ELI) (Weld Metal)
Specification:	
Form:	Sheet-TIG welded, Ti-6Al-4V filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Soltuion treated and aged (1660 F/5 min, WQ; 1000 F/4 hours, AC)

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1027 (149)		1615 (234.3)	1898 (275.3)		
	Min	1020 (148)		1598 (231.8)	1850 (268.3)		
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (2)		4 (2)	4 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 56753, 58024

TABLE 9.3.1-ME3

Alloy Designation: Ti-6Al-4V (ELI)

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	892 (129.4)		1418 (205.7)	1640 (237.8)		
	Min	858 (124.5)		1362 (197.6)	1626 (235.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	841 (122)		1331 (193)	1601 (232.2)		
	Min				1599 (232.0)		
Std. Deviation							
Elong, percent	Avg	14.7		7.7			
	Min	14		6			
RA, percent	Avg	37		17	8.5		
	Min	34		13	6		
No. of Spec. (No. of Heats)		4 (2)		4 (2)	3 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	867 (125.8)		1363 (197.7)	1617 (234.6)		
	Min	862 (125.0)		1362 (197.5)	1597 (231.6)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	841 (122)		1331 (193)	1575 (228.5)		
	Min				1553 (225.3)		
Std. Deviation							
Elong, percent	Avg	15.5		6			
	Min	15		6			
RA, percent	Avg	44		19	9		
	Min				8		
No. of Spec. (No. of Heats)		2 (2)		2 (2)	2 (2)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 75531, 79816, 87195

TABLE 9.3.1-ME4

Alloy Designation: Ti 6Al-4V (ELI)

Specification:
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297	(75)		77	(-320)	20	(-423)		
Compression, Longitudinal										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Compression, Transverse										
CYS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Shear[a]										
SUS, MN/m^2 (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m^2 (10^6 psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Impact, Charpy V										
Long., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Trans., Nm(ft-lb)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Fracture Toughness[b]										
K_{Ic} $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg									
	Min									
Orientation: –										
No. of Spec. (No. of Heats)										
K_{IE}, $MN/m^{3/2}$ (ksi$\sqrt{in.}$)	Avg	85.2	(78)		77.3	(70.7)	57.2	(52.3)		
(From PTSC spec.)(L – S)	Min				71.0	(65.0)	54.6	(50.0)		
No. of Spec. (No. of Heats)			(1)		3	(1)	3	(1)		

References: 79816

(a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data:

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TABLE 9.3.1-ME4.1

Alloy Designation:	**Ti-6Al-4V(ELI) (Weld Metal)**
Specification:	
Form:	**Plate-TIG welded, Ti-6Al-4V(ELI) filler**
Thickness, cm (in.):	**0.635 to 1.269 (0.250 to 0.499)**
Condition:	**Annealed, tested as welded**

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	994 (114.2)		1524 (221.0)	1674 (242.8)		
	Min	993 (144.0)		1521 (220.6)	1642 (238.2)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	916 (132.9)		1480 (214.6)			
	Min	909 (131.8)		1473 (213.7)			
Std. Deviation							
Elong, percent	Avg	6.7		4.3			
	Min	6.0		4.0			
RA, percent	Avg	14.7		13.7	13.3		
	Min	14		11	11		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 75531

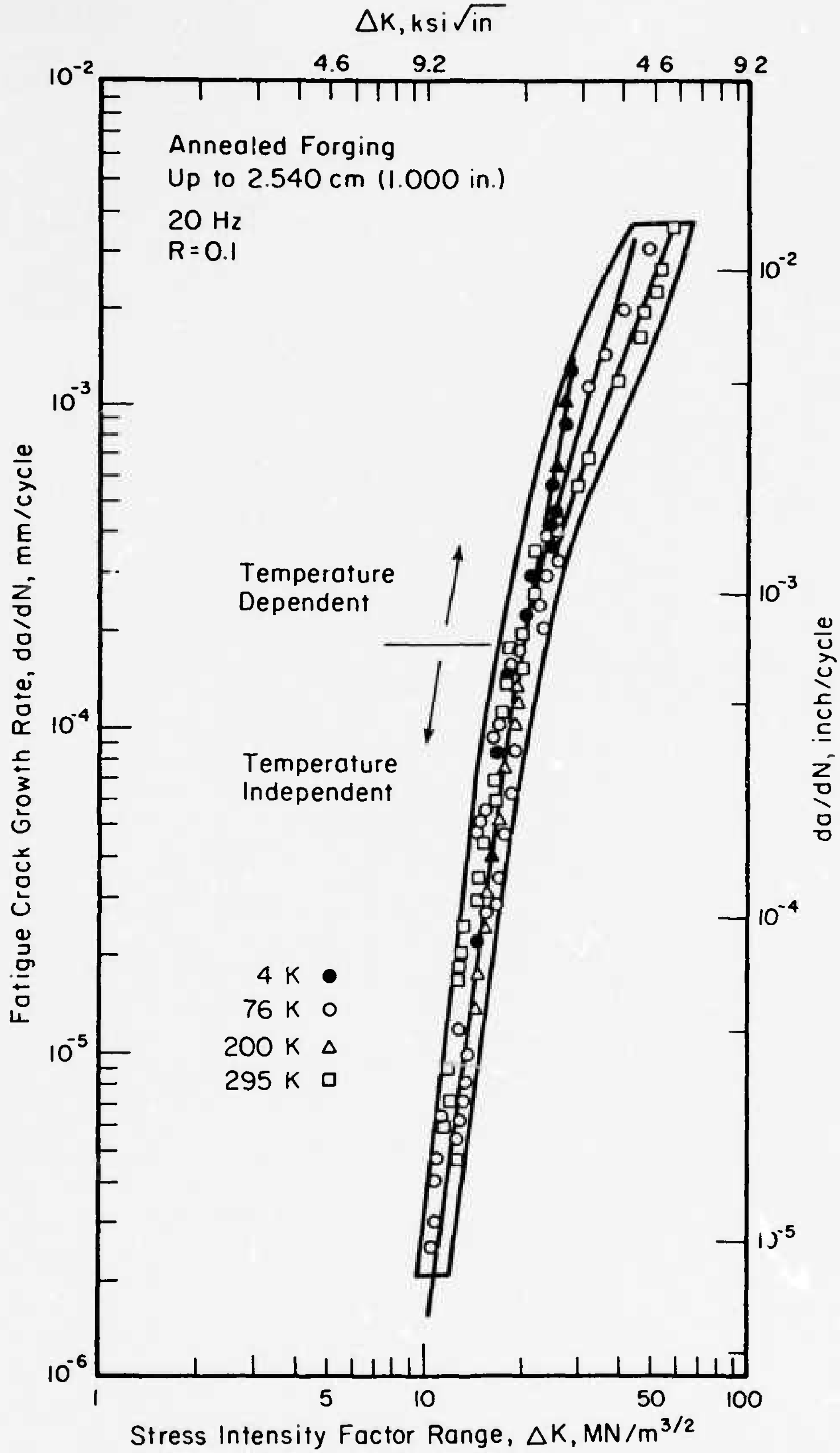

FIGURE 9.3.1-ME2. FATIGUE CRACK GROWTH RATES FOR Ti-6Al-4V (ELI) ALLOY AT 4K, 76K, 200K AND 295K (-452F, -321F, -103F AND 73F)(94208C)

TABLE 9.3.1-TR1

Alloy Designation: Ti-6Al-4V(ELI) Alloy

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	H tesla	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity							
Watts m^{-1} K^{-1}					1.58	0.90	0.43
Btu hr^{-1} ft^{-1} F^{-1}					(0.91)	(0.52)	(0.25)
No. of Spec.					1	1	1
References: 96888							
Thermal Expansion (T_{273} to T) Longitudinal							
Percent							
No. of Spec.							
References:							
Specific Heat							
Joules kg^{-1} K^{-1}							
Btu lb^{-1} F^{-1}							
No. of Spec.							
References:							
Electrical Resistivity							
Ohm m		156×10^{-8}	139×10^{-8}	135×10^{-8}	133×10^{-8}		
Ohm circular mil ft^{-1}		(938)	(836)	(812)	(800)		
No. of Spec.		1	1	1	1		
References: 79561							
Magnetothermal Conductivity							
Watts m^{-1} K^{-1}	0				1.58	0.90	0.43
Btu hr^{-1} ft^{-1} F^{-1}					(0.91)	(0.52)	(0.25)
Watts m^{-1} K^{-1}	1				1.57	0.89	0.39
Btu hr^{-1} ft^{-1} F^{-1}					(0.91)	(0.51)	(0.23)
Watts m^{-1} K^{-1}	4				1.56	0.87	0.38
Btu hr^{-1} ft^{-1} F^{-1}					(0.90)	(0.50)	(0.22)
Watts m^{-1} K^{-1}	8				1.56	0.86	0.35
Btu hr^{-1} ft^{-1} F^{-1}					(0.90)	(0.50)	(0.20)
No. of Spec.					1	1	1
References: 96888							

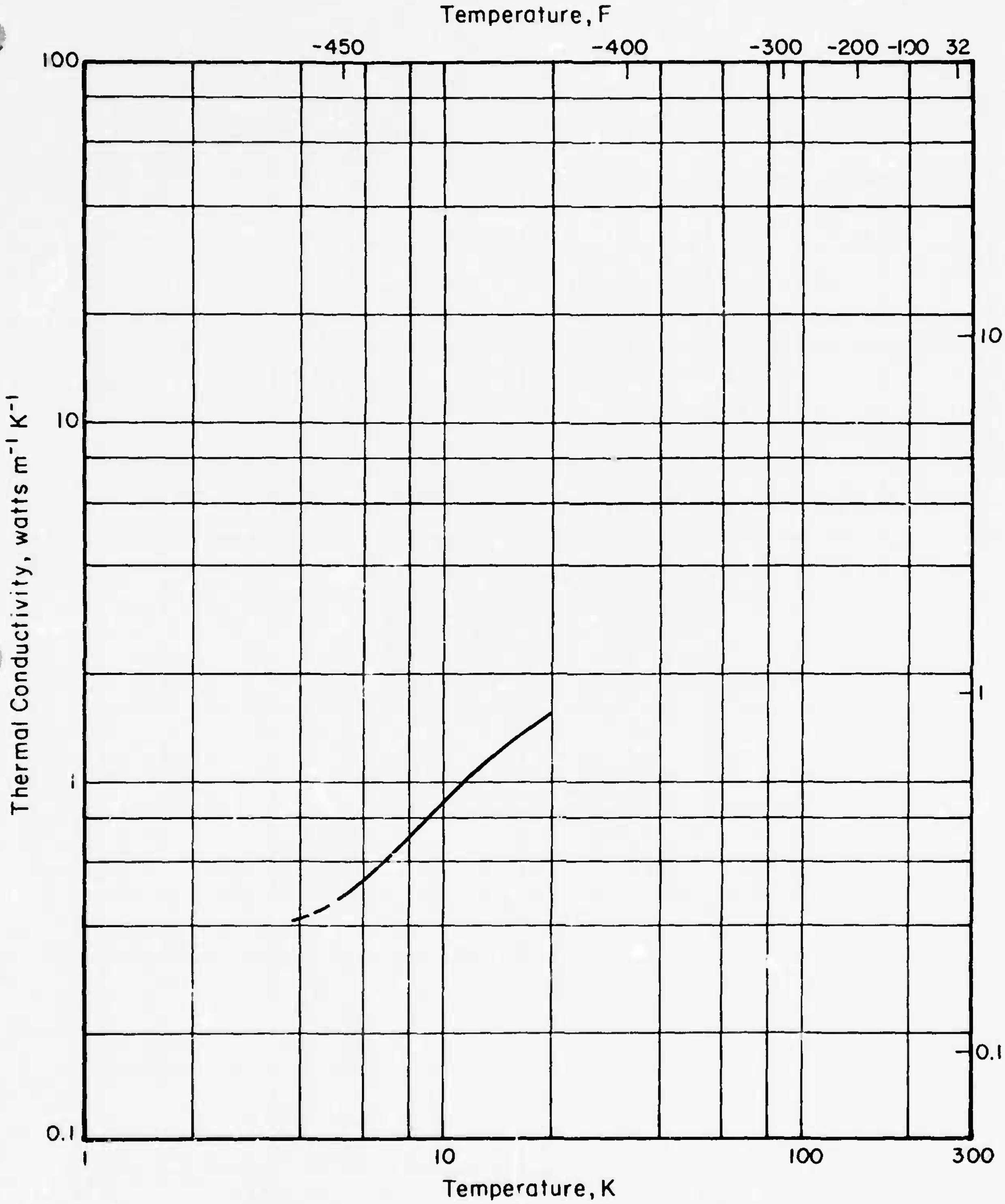

FIGURE 9.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Ti-6Al-4V(ELI) ALLOY

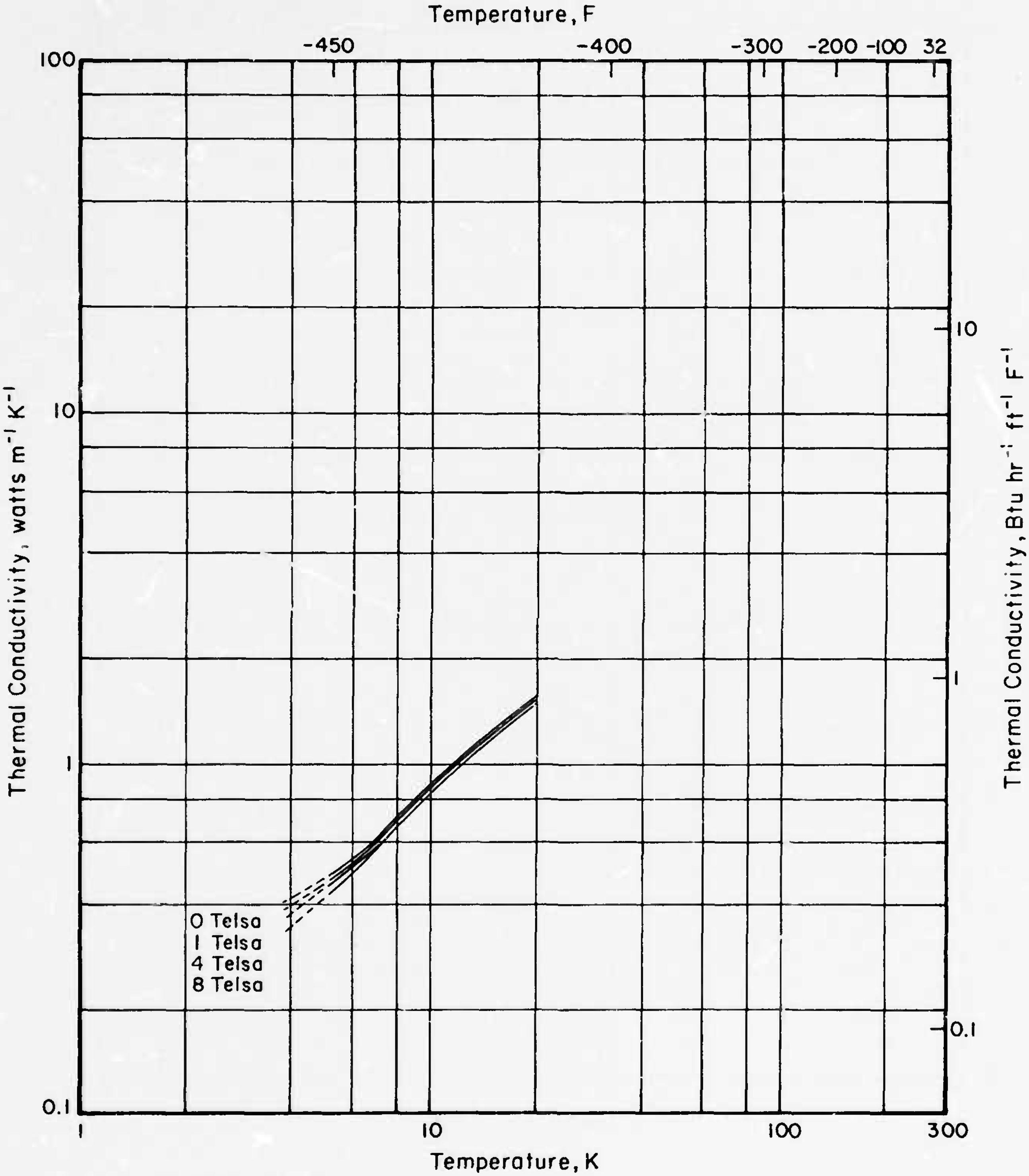

FIGURE 9.3.1-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Ti-6Al-4V(ELI) ALLOY AT SEVERAL MAGNETIC FIELDS

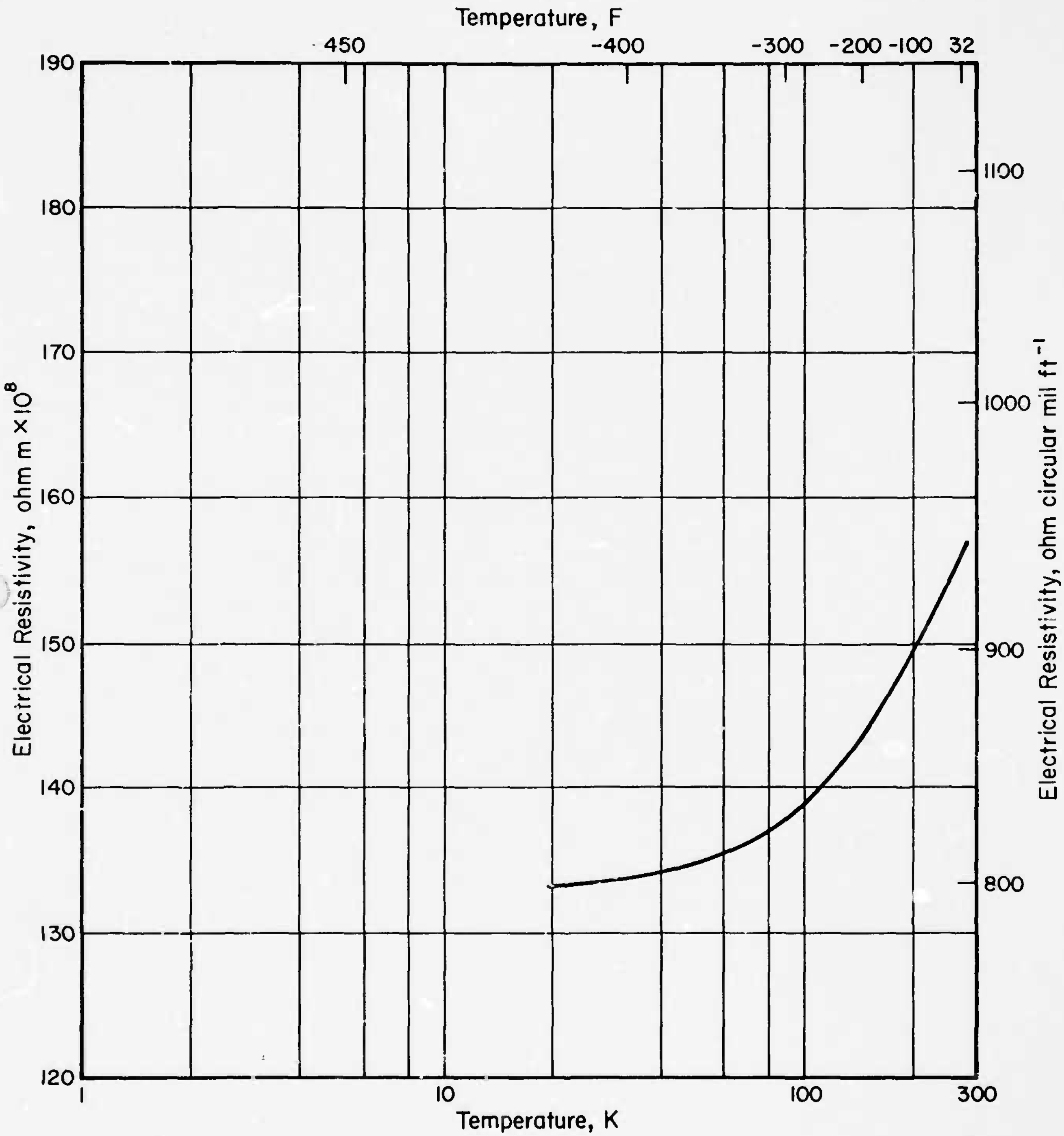

FIGURE 9.3.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR Ti-6Al-4V(ELI) ALLOY

TABLE 9.3.2-ME1

Alloy Designation:	Ti-6Al-4V (Nominal Interstitial Content)
Specification:	
Form:	Sheet
Thickness, cm (in.):	Up to 0.099 (0.039)
Condition:	STA

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1151 (167)	1344.5 (195)	1737.5 (252)	1950.5 (282.9)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1052 (152.6)	1253 (181.7)	1648 (239)	1900 (275.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	7.9	5.0	5.9	2.7		
	Min						
RA, percent	Avg	32.3		21.0	15.8		
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg	114 (16.6)	116 (16.8)	125 (18.2)	123 (17.9)		
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.300		0.290	0.280		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1169 (169.5)	1404 (203.7)	1696 (246)	1929 (279.8)		
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1082 (157)	1303 (189)	1619 (234.8)	1855 (269)		
	Min						
Std. Deviation							
Elong, percent	Avg	6.9	4.6	4.5	2.5		
	Min						
RA, percent	Avg	29.9		21.4	16.9		
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg	123 (17.9)	121 (17.5)	127 (18.4)	132 (19.1)		
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.310		0.300	0.270		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 64353, 89716, 89983

TABLE 9.3.2-ME2

Alloy Designation: Ti-6Al-4V (Weld Metal)

Specification:
Form: Sheet-TIG welded, Ti-6Al-4V filler
Thickness, cm (in.): Up to 0.099 (0.039)
Condition: Post weld treatment, stress relieved in vacuum furnace at 811 K (1000 F) for 4 hours

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1099 (159.4)			1910 (277)		
	Min	1083 (157.1)			1870 (271.2)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1078 (156.3)			1910 (277)		
	Min	1054 (152.8)			1870 (271.2)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	0.4			0.75		
	Min	0.3			0.50		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 89983

TABLE 9.3.2-ME3

Alloy Designation:	Ti-6Al-4V (Nominal Intersititial Content)
Specification:	
Form:	Sheet
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	STA

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)		
Tension, Longitudinal											
TUS, MN/m^2 (ksi)	Avg	1112	(161.3)	1330	(192.9)	1679	(243.6)	1826	(264.9)		
	Min	938	(136.0)	1112	(161.3)	1504	(218.1)	1468	(213.0)		
Std. Deviation		107	(15.53)	139	(20.21)	129	(18.71)	220	(31.94)		
TYS, MN/m^2 (ksi)	Avg	1030	(149.4)	1200	(174.0)	1584	(229.8)	1693	(245.6)		
	Min	876	(127.0)	834	(121.0)	1172	(170.0)	1296	(188.0)		
Std. Deviation		101	(14.69)	184	(26.65)	177	(25.72)	255	(37.0)		
Elong, percent	Avg	11.6		6.7		7.7		4.9			
	Min	5.8		2.5		3.8		1.0			
RA, percent	Avg	31.1		23.5		17.5		25.0			
	Min	24.5		16.1		10.8		15.0			
No. of Spec. (No. of Heats)		17	(9)	9	(5)	14	(7)	18	(8)		
E, GN/m^2 (10^6 psi)	Avg	112	(16.2)	117	(16.9)	122	(17.7)	126	(18.3)		
	Min	104	(15.1)	114	(16.6)	121	(17.5)	113	(16.4)		
No. of Spec. (No. of Heats)		9	(5)	5	(2)	7	(3)	10	(4)		
Poisson's Ratio		0.333						0.368			
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg	1333	(193.4)	1517	(220)	1932	(280.2)	2077	(301.3)		
K_t = 3-3.5	Min	1296	(188.0)	1489	(216)	1682	(244.0)	1773	(257.1)		
No. of Spec. (No. of Heats)		6	(2)	3	(1)	5	(2)	6	(2)		
NTS, MN/m^2 (ksi)	Avg	1172	(170)			1444	(209.5)	1262	(275.6)		
K_t = 6.3	Min	1172	(170)			1351	(196.0)	1193	(173)		
No. of Spec. (No. of Heats)		2	(1)			2	(1)	2	(1)		
Tension, Transverse											
TUS, MN/m^2 (ksi)	Avg	1174	(170.3)	1326	(192.3)	1679	(243.5)	1900	(275.6)		
	Min	1034	(150.0)	1175	(170.4)	1489	(216.0)	1668	(241.9)		
Std. Deviation		65	(9.44)								
TYS, MN/m^2 (ksi)	Avg	1076	(156.0)	1202	(174.4)	1586	(230)	1801	(261.2)		
	Min	876	(127.0)	979	(142.0)	1337	(194)	1656	(240.2)		
Std. Deviation		81.4	(11.81)								
Elong, percent	Avg	10.5		6.4		7.6		3.0			
	Min	6.0		5.0		4.0		2.0			
RA, percent	Avg	31.7									
	Min	22.3									
No. of Spec. (No. of Heats)		10	(5)	5	(3)	5	(3)	3	(2)		
E, GN/m^2 (10^6 psi)	Avg	112	(16.3)	114	(16.6)	119	(17.3)	125	(18.1)		
	Min	104	(15.1)	113	(16.4)	116	(16.9)				
No. of Spec. (No. of Heats)		7	(3)	3	(1)	3	(1)	1	(1)		
Poisson's Ratio		0.309						0.372			
Work Hardening Coef											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
No. of Spec. (No. of Heats)											

References: 37146, 47311, 49048, 49088, 58024, 58060, 78652, 89983, 90172, 90185

TABLE 9.3.2-ME4

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content) (Weld Metal)

Specification:	
Form:	Sheet-TIG welded, Ti-6Al-4V filler
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	967 (140.3)	1130 (163.9)	1521 (220.6)	1740 (252.4)	1663 (241.2)	
	Min	956 (138.6)	1102 (159.8)	1519 (220.3)	1584 (229.7)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	916 (132.9)	1071 (155.4)	1495 (216.8)	1562 (226.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.7	8.0	8.6	3.0	1.0	
	Min	7.5	6.0	7.3	2.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)	2 (2)	2 (2)	2 (2)	1 (1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 58060, 90185

TABLE 9.3.2-ME5

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content) (Weld Metal)

Specification:
Form: Sheet-TIG welded, Ti-6Al-4V filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: STA, post weld treated, stress relieved in a vacuum furnace at 811 K (1000 F) for 4 hours

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1119 (162.3)			1952 (283.1)		
	Min	1113 (161.5)			1927 (279.5)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1093 (158.5)			1952 (283.1)		
	Min	1082 (157.0)			1927 (279.5)		
Std. Deviation							
Elong, percent	Avg	1.0			1.5		
	Min	0.6			1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 89983

TABLE 9.3.2-ME6

Alloy Designation: Ti-6Al-4V Alloy

Specification: MIL-T-9046 F, Type III, Composition C
Form: Plate
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	**917 (133.0)**	**1485 (215.4)**				
	Min	905 (131.2)	1482 (214.9)				
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	**838 (121.6)**	**1378 (199.8)**				
	Min	828 (120.1)	1360 (197.3)				
Std. Deviation							
Elong, percent	Avg	**18.5**	**20.1**				
	Min	18.1	17.3				
RA, percent	Avg	**14.2**	**12.3**				
	Min	13.4	9.9				
No. of Spec. (No. of Heats)		3(1)	3(1)				
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 90624

73[illegible]

TABLE 9.3.2-ME7

Alloy Designation:	Ti-6Al-4V (Nominal Interstitial Content)
Specification:	
Form:	Plate
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	STA

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1158 (168.0)		1734 (251.5)	1758 (255.0)		
	Min	1120 (162.4)		1703 (247.0)	1398 (202.8)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1062 (154)		1620 (235)	1937 (281)		
	Min	1022 (148.2)		1544 (224)	1855 (269)		
Std. Deviation							
Elong, percent	Avg	6.2		8.0	3.0		
	Min	3.0		3.0	3.0		
RA, percent	Avg	17.4		14.6	17.3		
	Min	4.0		4.0	15.9		
No. of Spec. (No. of Heats)		5 (3)		3 (2)	5 (3)		
E, GN/m^2 (10^6 psi)	Avg	114 (16.6)		133 (19.25)	123 (17.89)		
	Min	108 (15.6)		132 (19.20)	120 (17.40)		
No. of Spec. (No. of Heats)		3 (2)		2 (1)	3 (2)		
Poisson's Ratio		0.300		0.290	0.270		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1172 (170.0)		1710 (248)	1779 (258)		
	Min	1129 (163.8)		1689 (245)	1531 (222)		
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1082 (157.0)		1620 (235)	1855 (269)		
	Min	1055 (153.1)		1558 (226)	1800 (261)		
Std. Deviation							
Elong, percent	Avg	6.0		4.8	2.7		
	Min						
RA, percent	Avg	16.7		16.2	16.3		
	Min	2.0		4.0	14.6		
No. of Spec. (No. of Heats)		5 (3)		3 (2)	5 (3)		
E, GN/m^2 (10^6 psi)	Avg	122 (17.67)		134 (19.4)	132 (19.1)		
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.310		0.300	0.270		
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 89716, 89983, 91696

TABLE 9.3.2-ME8

Alloy Designation:	Ti-6Al-4V (Nominal Interstitial Content) (Weld Metal)
Specification:	
Form:	Plate-TIG welded, Ti-6Al-4V filler
Thickness, cm (in.):	0.635 to 1.269 (0.250 to 0.499)
Condition:	Stress relieved, 1300 F, 1 hour at Temp., air colled after welding

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	967 (140.3)		1516 (219.9)			
	Min	961 (139.4)		1500 (217.6)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	12.0		14.3			
	Min	11.0		11.5			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)		3 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49088

TABLE 9.3.2-ME9

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: STA

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1096 (159)		1544 (224)			
	Min			1542 (223.7)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1027 (149)	1228 (178.1)	1486 (215.5)			
	Min	1007 (146)	1228 (178.1)	1453 (210.7)			
Std. Deviation				44.3 (6.42)			
Elong, percent	Avg	8.0		8.0			
	Min	8.0		7.5			
RA, percent	Avg	9.0		19.7			
	Min	9.0		17.9			
No. of Spec. (No. of Heats)		4 (2)	3 (1)	14 (3)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1117 (162)					
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	1007 (146)					
	Min						
Std. Deviation							
Elong, percent	Avg	8.0					
	Min	8.0					
RA, percent	Avg	9.0					
	Min	9.0					
No. of Spec. (No. of Heats)		1 (1)					
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 55916, 76411, 80994, 91696

TABLE 9.3.2-ME10

Alloy Designation:	**Ti-6Al-4V (Nominal Interstitial Content)**
Specification:	
Form:	Bar
Thickness, cm (in.):	Up to 2.540 (1.000)
Condition:	Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1077 (156.2)	1308 (189.7)	1709 (247.9)	1854 (268.9)	1708 (248)	
	Min	923 (133.8)	1153 (167.2)	1524 (221.0)	1717 (249.0)	1708 (248)	
Std. Deviation		214 (31.01)			73.4 (10.65)		
TYS, MN/m^2 (ksi)	Avg	935 (135.6)	1124 (163.0)	1551 (225)	1751 (25.4)	1655 (240)	
	Min	883 (128.0)	1112 (161.3)	1475 (214)	1572 (228)	1655 (240)	
Std. Deviation		29.5 (4.28)			129 (18.67)		
Elong, percent	Avg	14.5	13.2	11.1	6.6	4.0	
	Min	12.0	12.0	9.0	1.9	4.0	
RA, percent	Avg	46.4	40.8	38.7	27.1	32.0	
	Min	42.0	38.5	32.5	2.7	32.0	
No. of Spec. (No. of Heats)		12 (4)	7 (3)	7 (3)	18 (4)	1 (1)	
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg	1271 (184.4)			1942 (281.6)		
K_t = 6.4	Min	1262 (183.0)			1875 (272.0)		
No. of Spec. (No. of Heats)		5 (1)			5 (1)		
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 35611, 47311, 49349, 54986, 64373

TABLE 9.3.2-ME11

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:
Form: Forgings
Thickness, cm (in.):
Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m^2 (ksi)	Avg	1166 (169.1)		1703 (247)	1780 (258.1)		
	Min	1014 (147.0)		1606 (233)	1686 (244.5)		
Std. Deviation					37.2 (5.4)		
TYS, MN/m^2 (ksi)	Avg	1034 (150)		1620 (235)	1655 (240)		
	Min	896 (130)		1565 (227)	1420 (206)		
Std. Deviation					56 (8.1)		
Elong, percent	Avg	16.0		8.2			
	Min	10.0		3.8			
RA, percent	Avg	35.1		23.4	26.8		
	Min	15.0		7.4	18.8		
No. of Spec. (No. of Heats)		3 (2)		3 (2)	82 (7)		
E, GN/m^2 (10^6 psi)	Avg				(21.6)		
	Min				(18.5)		
No. of Spec. (No. of Heats)					82 (7)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg			1689 (245)			
K_t = 6.3	Min			1631 (236.5)			
No. of Spec. (No. of Heats)				2 (1)			
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m^2 (ksi)	Avg	1069 (155)		1689 (245)			
	Min	1069 (155)		1689 (245)			
Std. Deviation							
TYS, MN/m^2 (ksi)	Avg	917 (133)		1627 (236)			
	Min	917 (133)		1627 (236)			
Std. Deviation							
Elong, percent	Avg	26.0		12.0			
	Min	26.0		12.0			
RA, percent	Avg	36.0		23.0			
	Min	36.0		23.0			
No. of Spec. (No. of Heats)		1 (1)		1 (1)			
E, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 49088, 90117, 90185

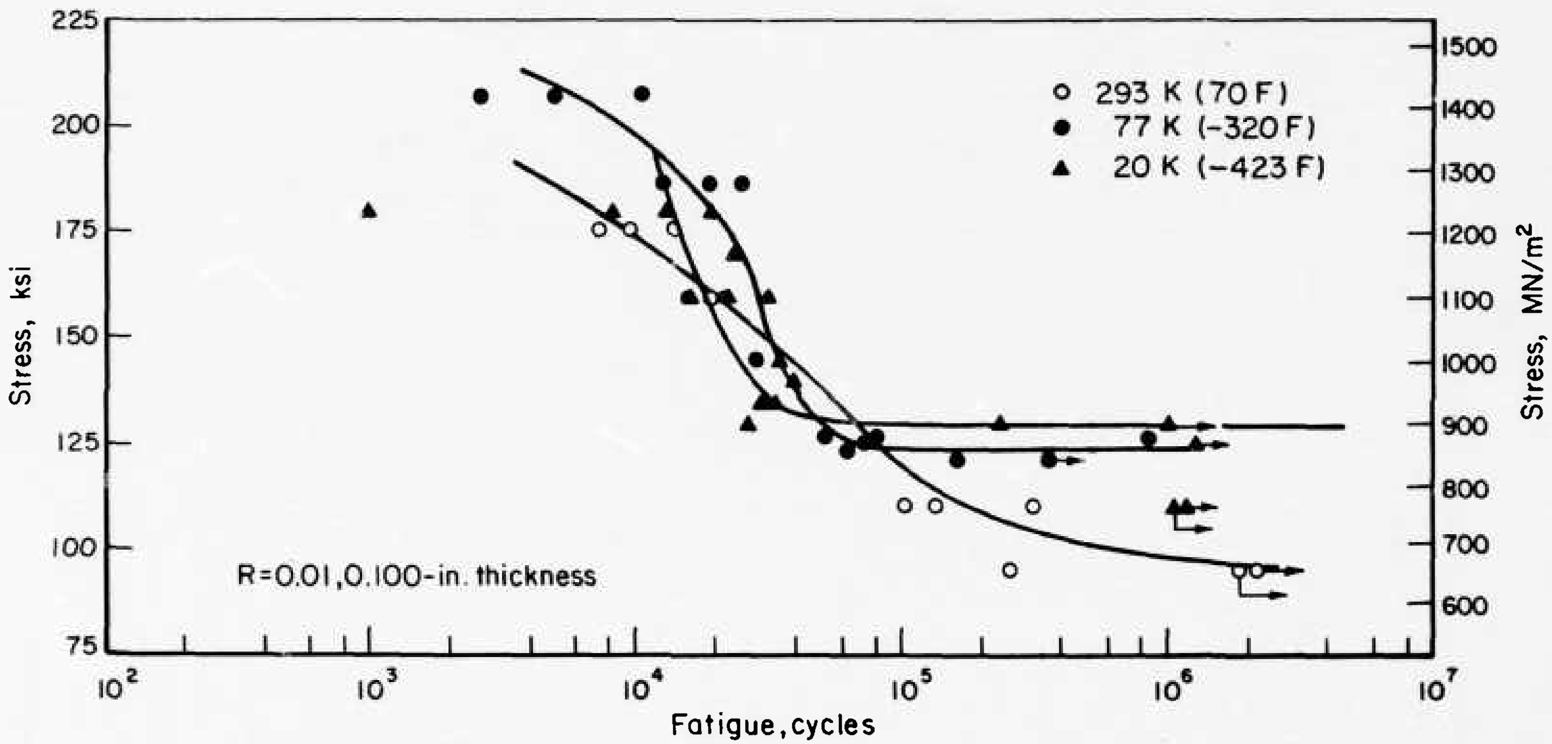

FIGURE 9.3.2-ME1. AXIAL FATIGUE LIFE CURVES FOR UNNOTCHED 6Al-4V (SOLUTION TREATED AND AGED) TITANIUM ALLOY [58024]

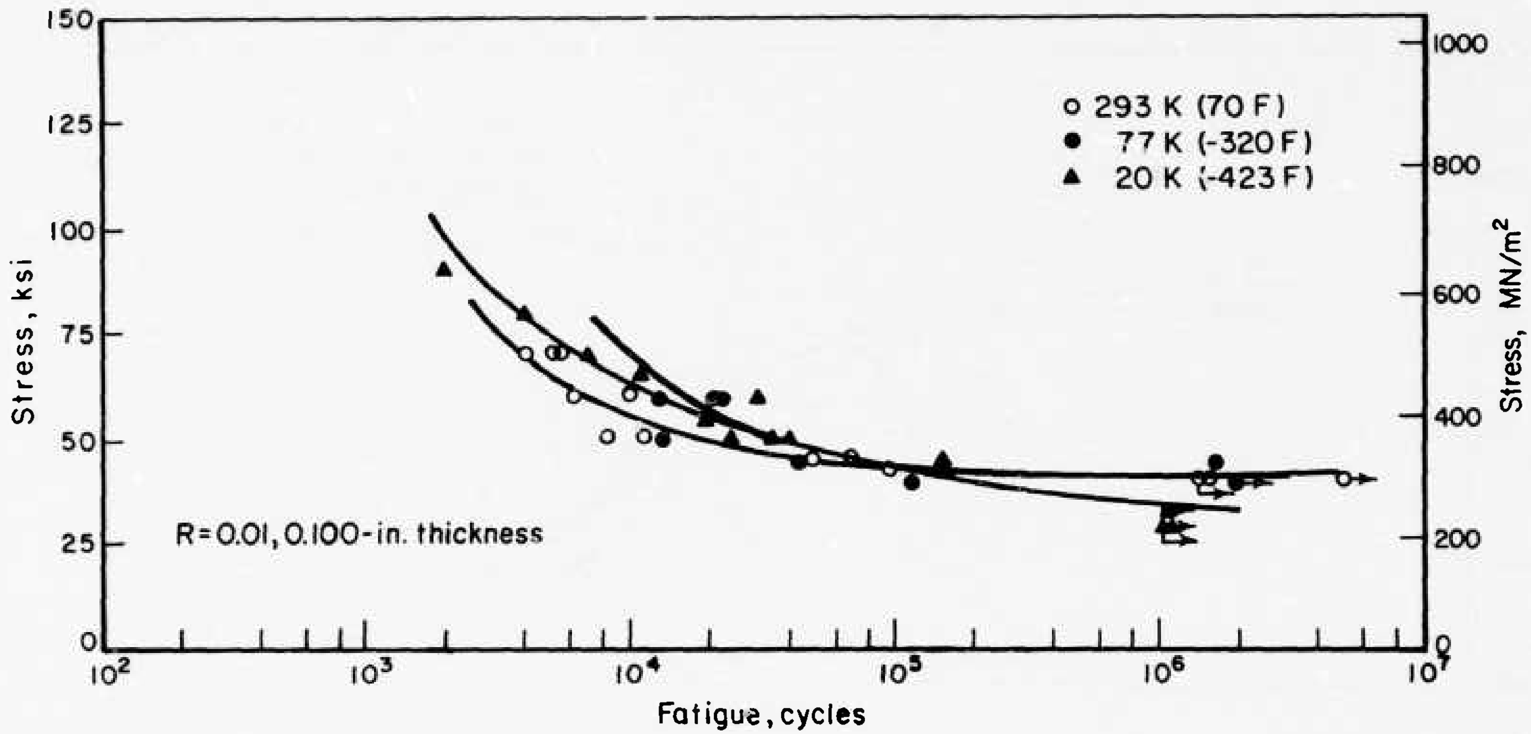

FIGURE 9.3.2-ME2. AXIAL FATIGUE LIFE CURVES FOR NOTCHED 6Al-4V (SOLUTION TREATED AND AGED) TITANIUM ALLOY [58024]

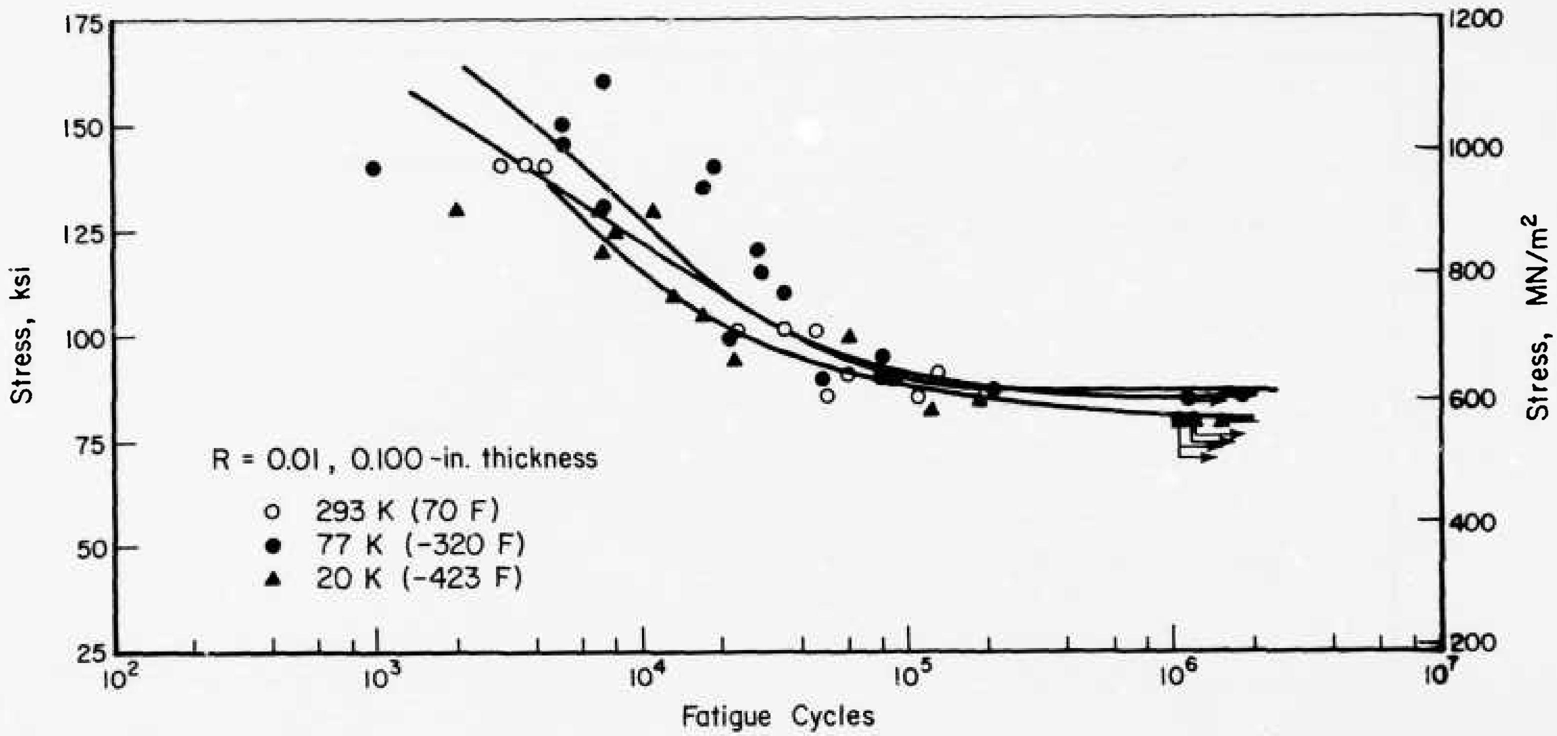

FIGURE 9.3.2-ME3. AXIAL FATIGUE LIFE CURVES FOR WELDED 6Al-4V (SOLUTION TREATED AND AGED) TITANIUM ALLOY [TIG welded; parent metal filler] [58024]

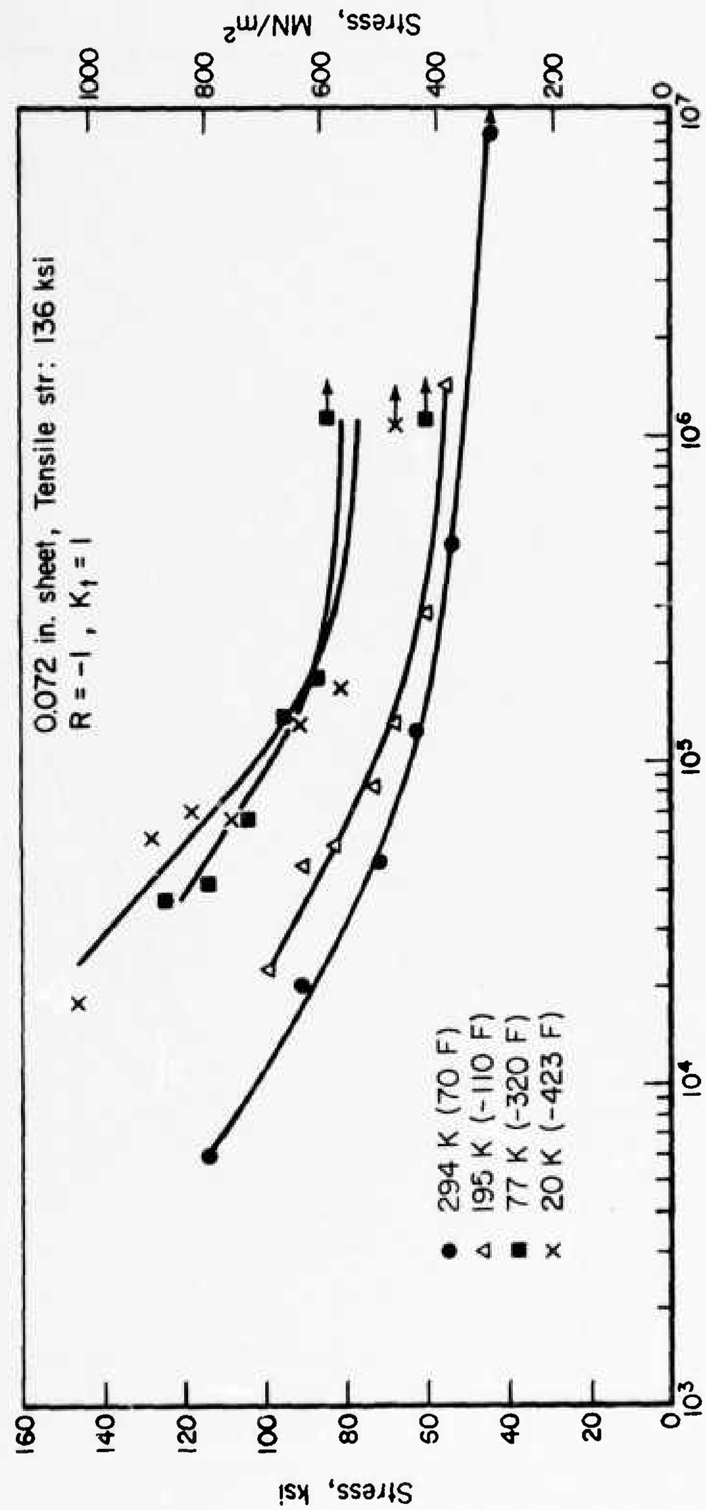

FIGURE 9.3.2-ME4. FLEXURAL FATIGUE LIFE CURVES FOR ANNEALED 6Al-4V TITANIUM [49048]

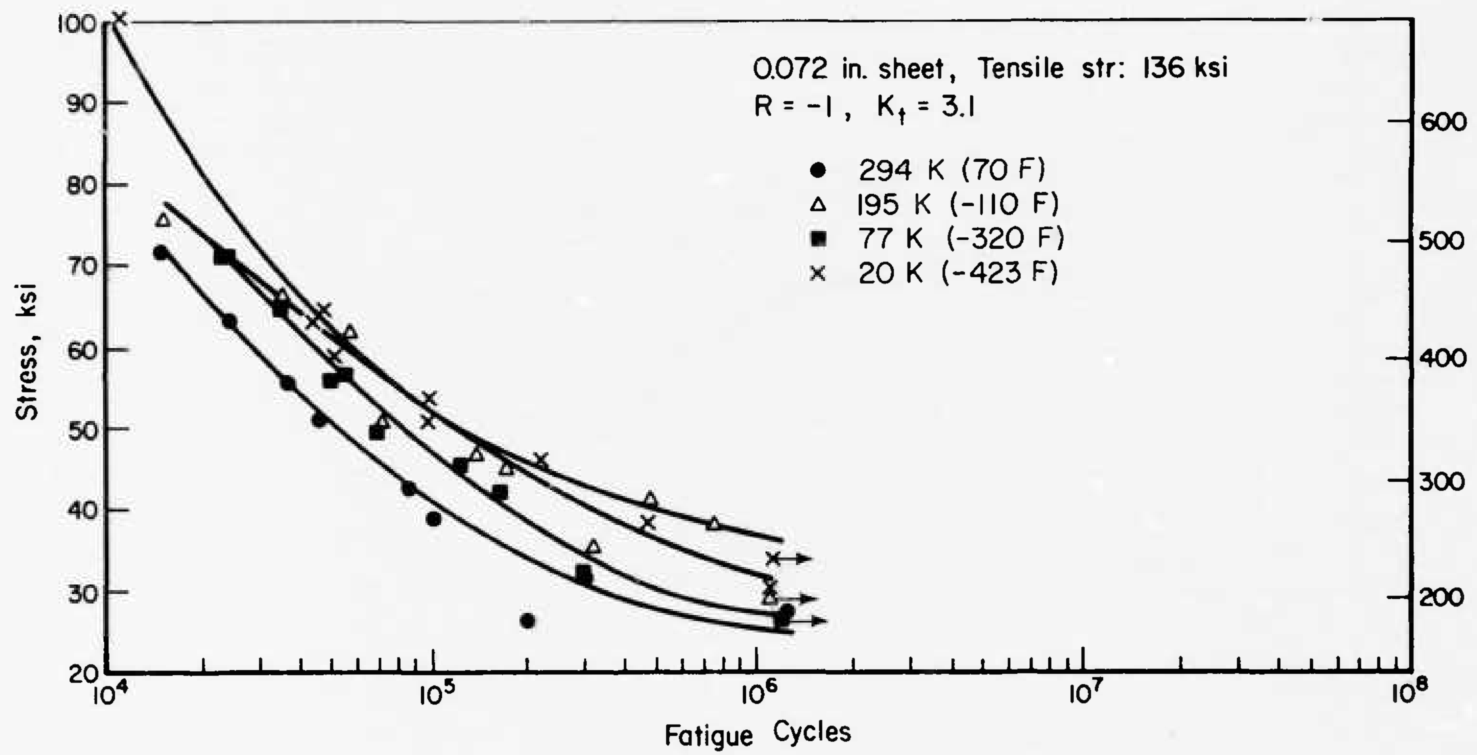

FIGURE 9.3.2-ME5. FLEXURAL FATIGUE LIFE CURVES FOR ANNEALED NOTCHED 6Al-4V TITANIUM [49048]

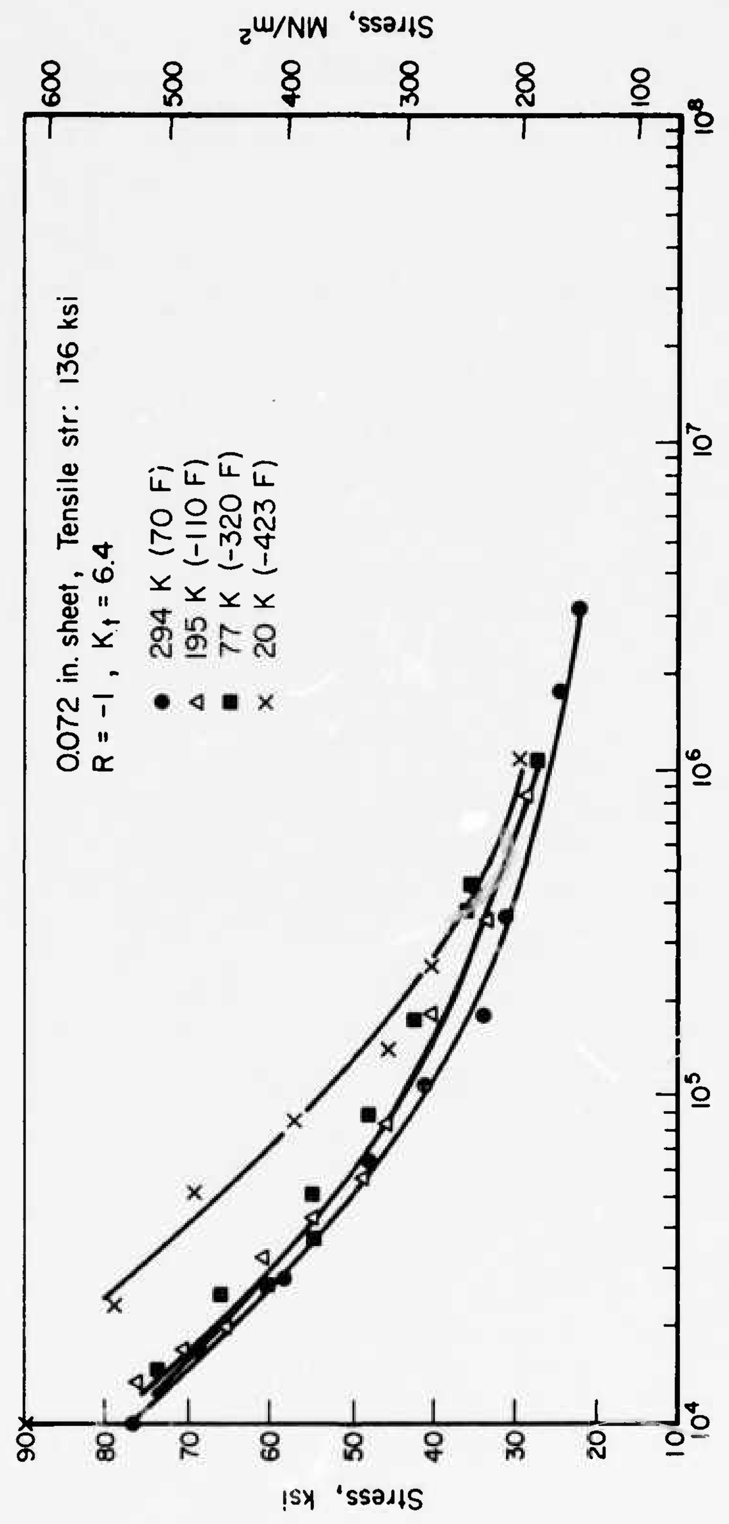

FIGURE 9.3.2-ME6. FLEXURAL FATIGUE LIFE CURVES FOR ANNEALED 6Al-4V TITANIUM [49048]

TABLE 9.3.1-TR1

Alloy Designation: Ti-6Al-4V Alloy

Specification:
Form:
Dimension:
Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.132	-0.150	-0.152		
No. of Spec.	3	3	3	1		
References: 48570, 90223						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	160×10^{-8}	145×10^{-8}	140×10^{-8}	138×10^{-8}		
Ohm circular mil ft^{-1}	(962)	(872)	(842)	(830)		
No. of Spec.	2	2	2	2		
References: 79561						

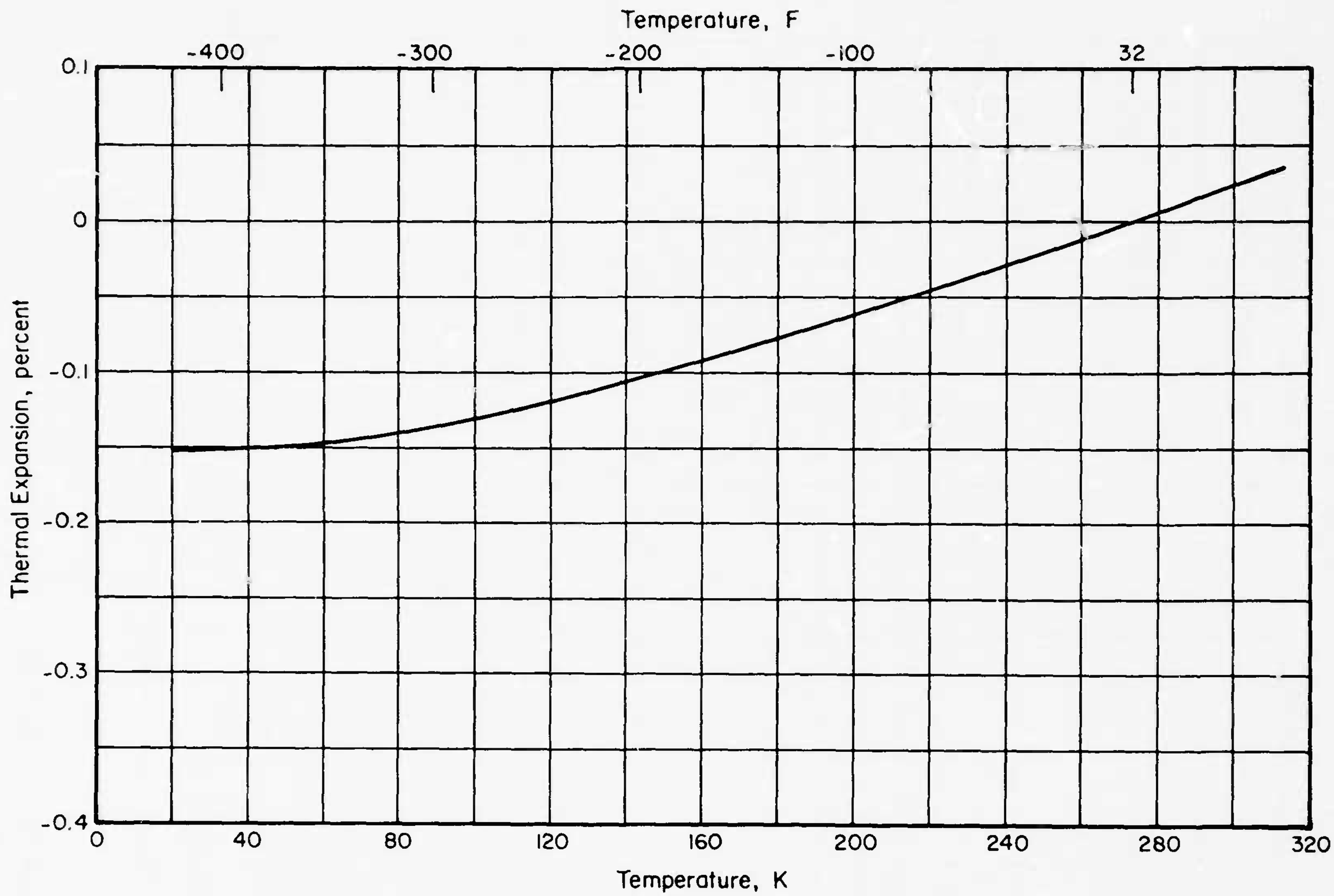

FIGURE 9.3.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Ti-6 Al-4 V ALLOY

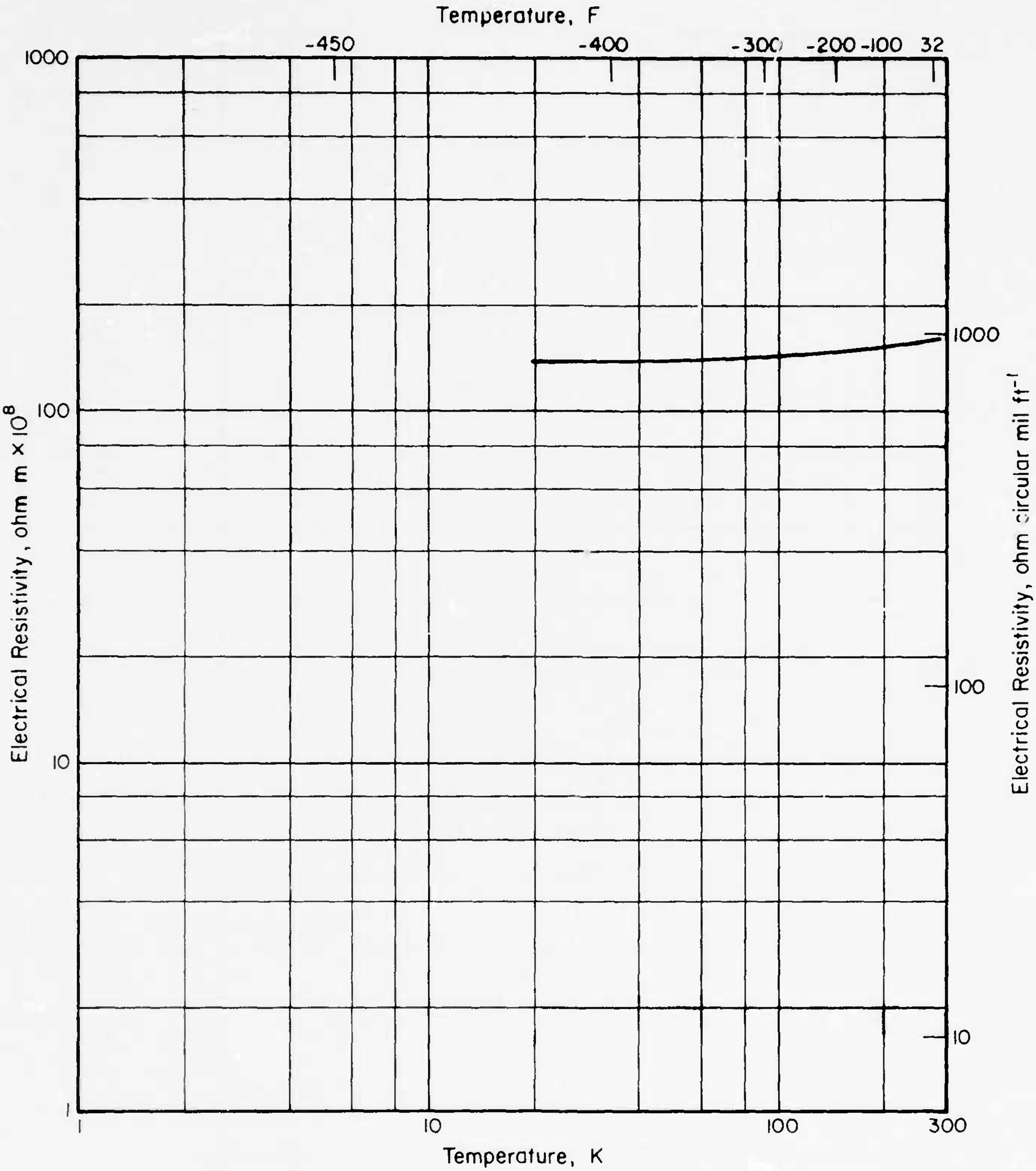

FIGURE 9.3.2-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR Ti-6 Al-4 V ALLOY

INDEX TO MATERIAL CODES FOR SECTION 10.0

SPECIAL METALS

MATERIALS	MATERIAL CODE
NIOBIUM	10.1.1
Nb_3Sn	10.1.2
NIOBIUM-ZIRCONIUM ALLOYS	10.1.3
TITANIUM-NIOBIUM ALLOYS	10.1.4
V_3Ga	10.2.1
MAGNESIUM ALLOYS-AZ31B	10.3.1

TABLE 10.1.3-TR1

Alloy Designation: Nb-0.2Zr Alloy

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						18.0(n)[a] 4.2(s)[b]
Btu hr^{-1} ft^{-1} F^{-1}						(10.4(n)) (2.43(s))
No. of Spec						1
References: 90341						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

(a) n Normal state
(b) s Superconducting state

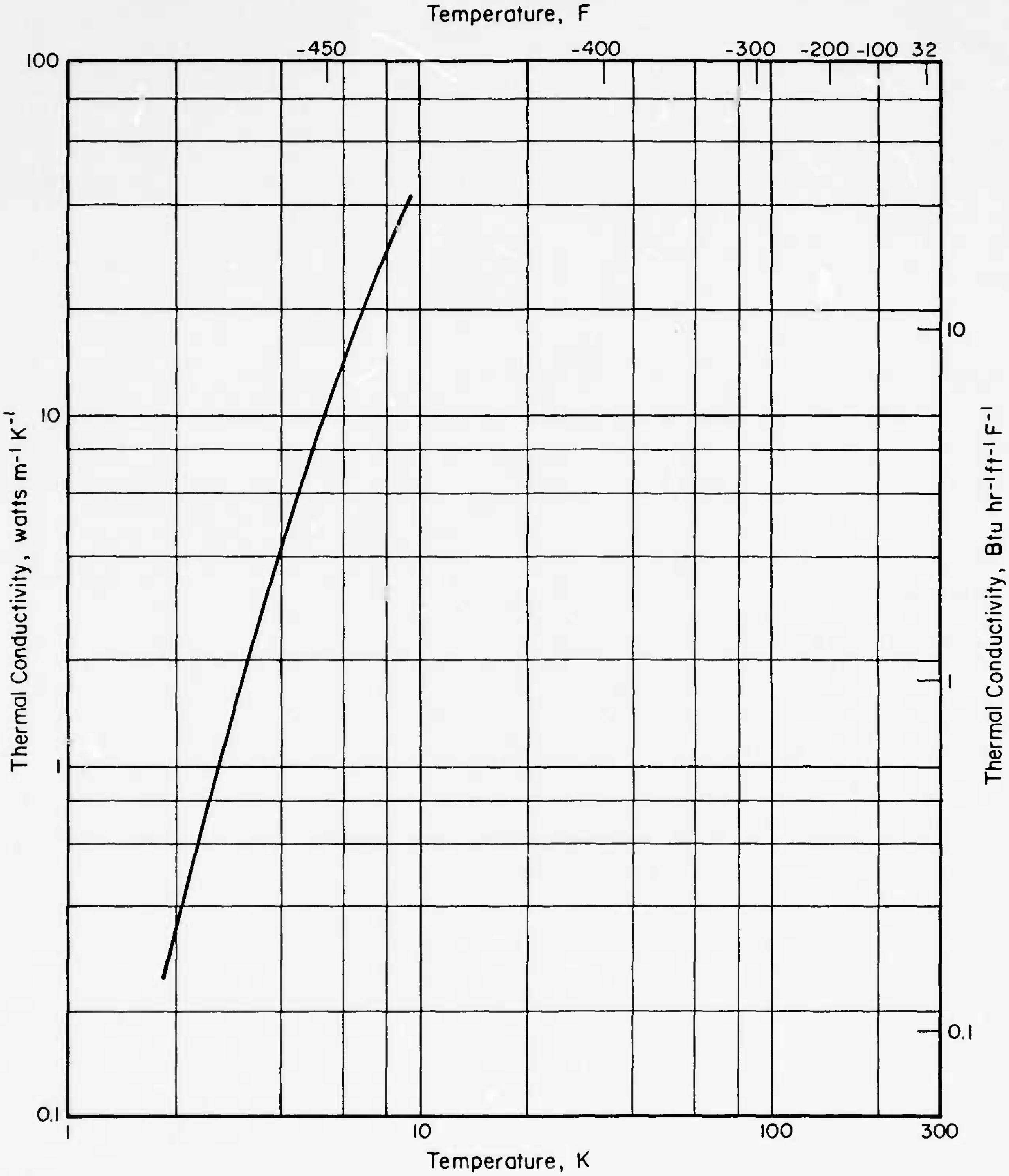

FIGURE 10.1.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb-0.2 Zr ALLOY – SUPERCONDUCTING STATE

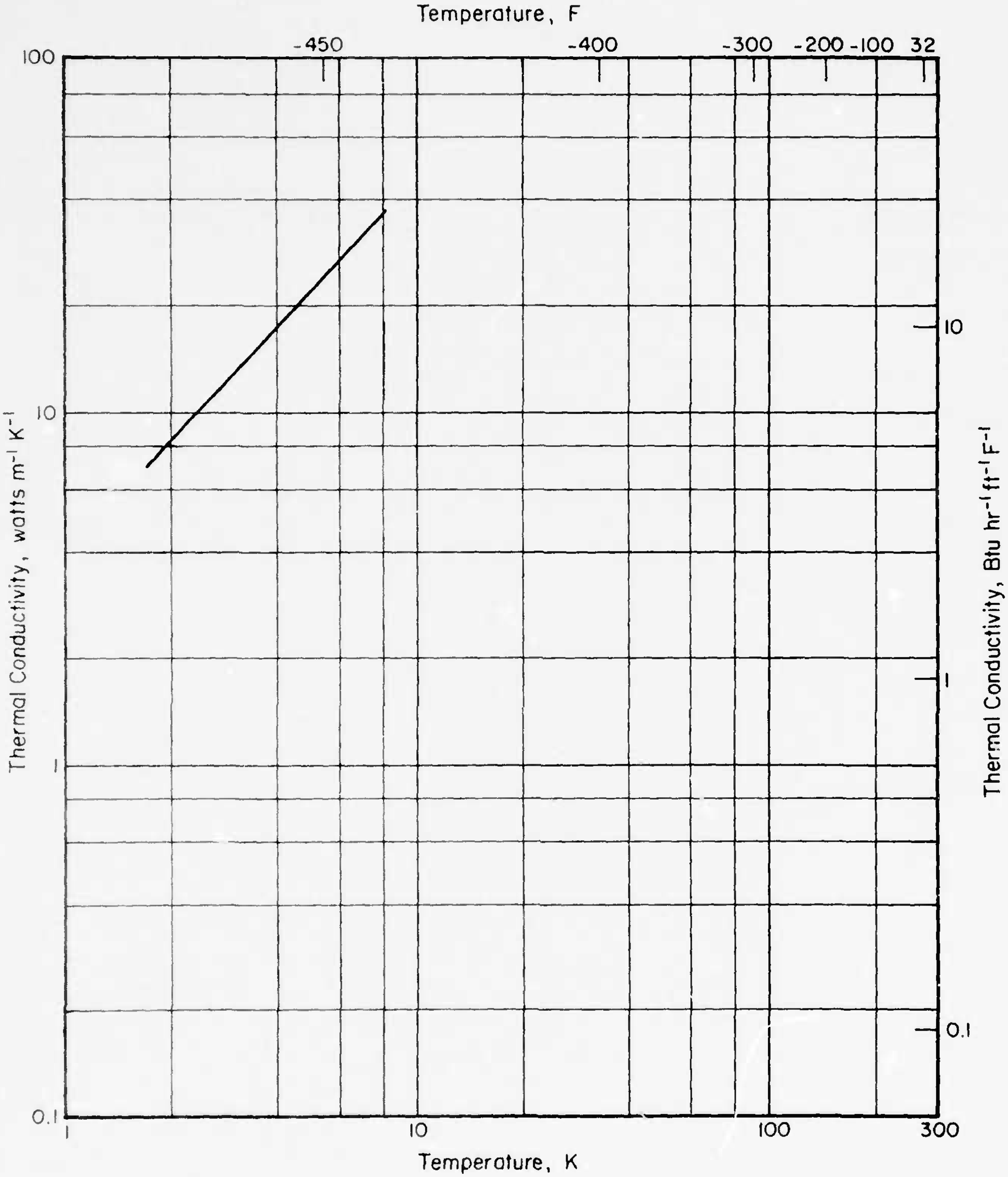

FIGURE 10.1.3-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb-0.2 Zr ALLOY – NORMAL STATE

TABLE 10.1.3-TR2

Alloy Designation: Nb-2Zr Alloy

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						17.0(n)[a] 4.05(s)[b]
Btu hr^{-1} ft^{-1} F^{-1}						(9.83(n)) (2.34(s))
No. of Spec.						1
References: 90341						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

(a) n Normal state
(b) s Superconducting state

TABLE 10.1.4-TR5

Alloy Designation: Nb-45Ti

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.137	-0.163	-0.168	-0.169	-0.169
No. of Spec.	1	1	1	1	1	1
References: 95168						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

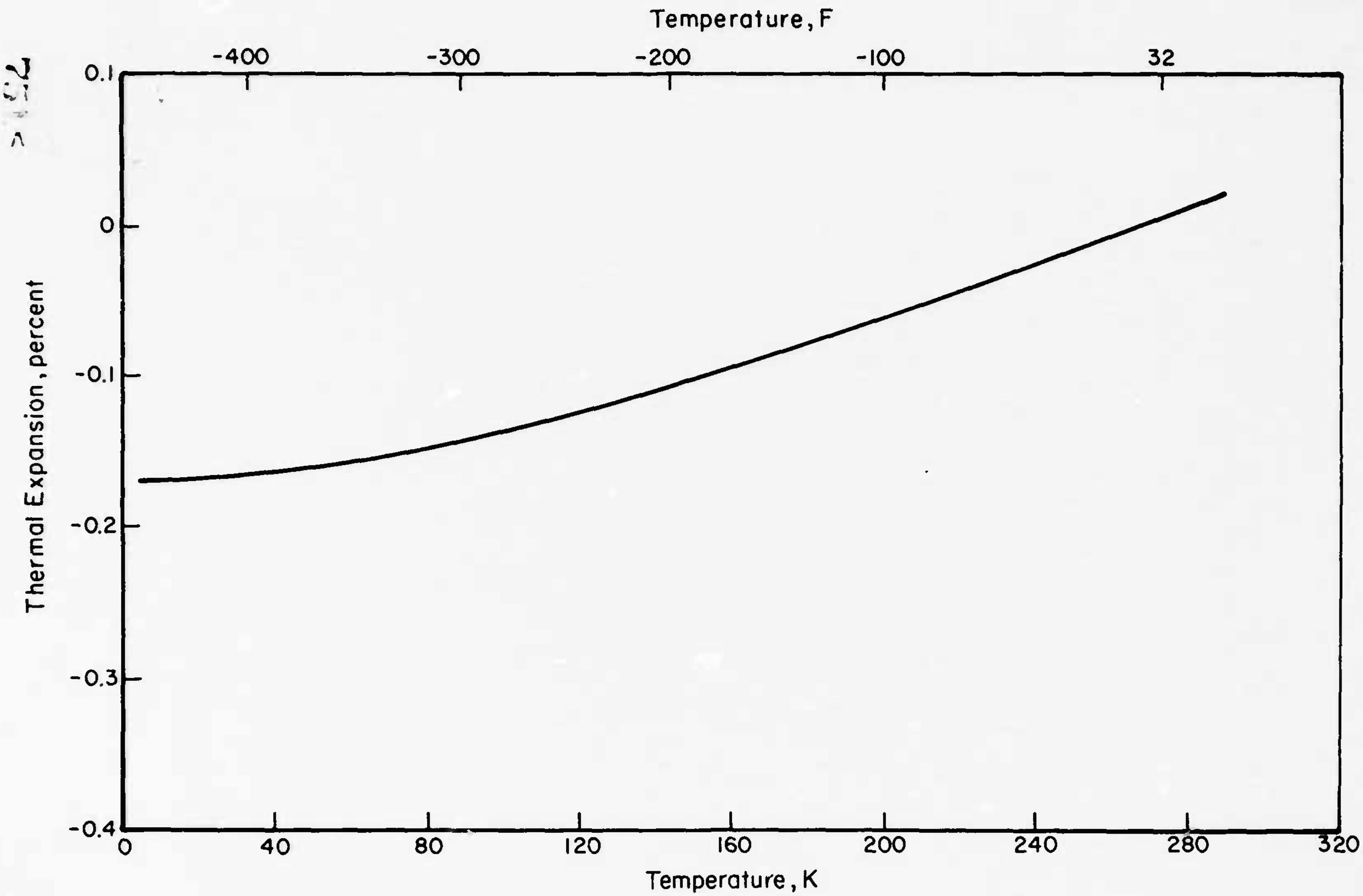

FIGURE 10.1.4-E5. THERMAL EXPANSION VERSUS TEMPERATURE FOR Nb-45Ti ALLOY

TABLE 10.1.4-TR6

Alloy Designation: Nb-48Ti

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.140	-0.163	-0.171	-0.172	-0.174
No. of Spec.	1	1	1	1	1	1
References: 95168						
Specific Heat						
Joules kg^{-1} K^{-1}						
Btu lb^{-1} F^{-1}						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft^{-1}						
No. of Spec.						
References:						

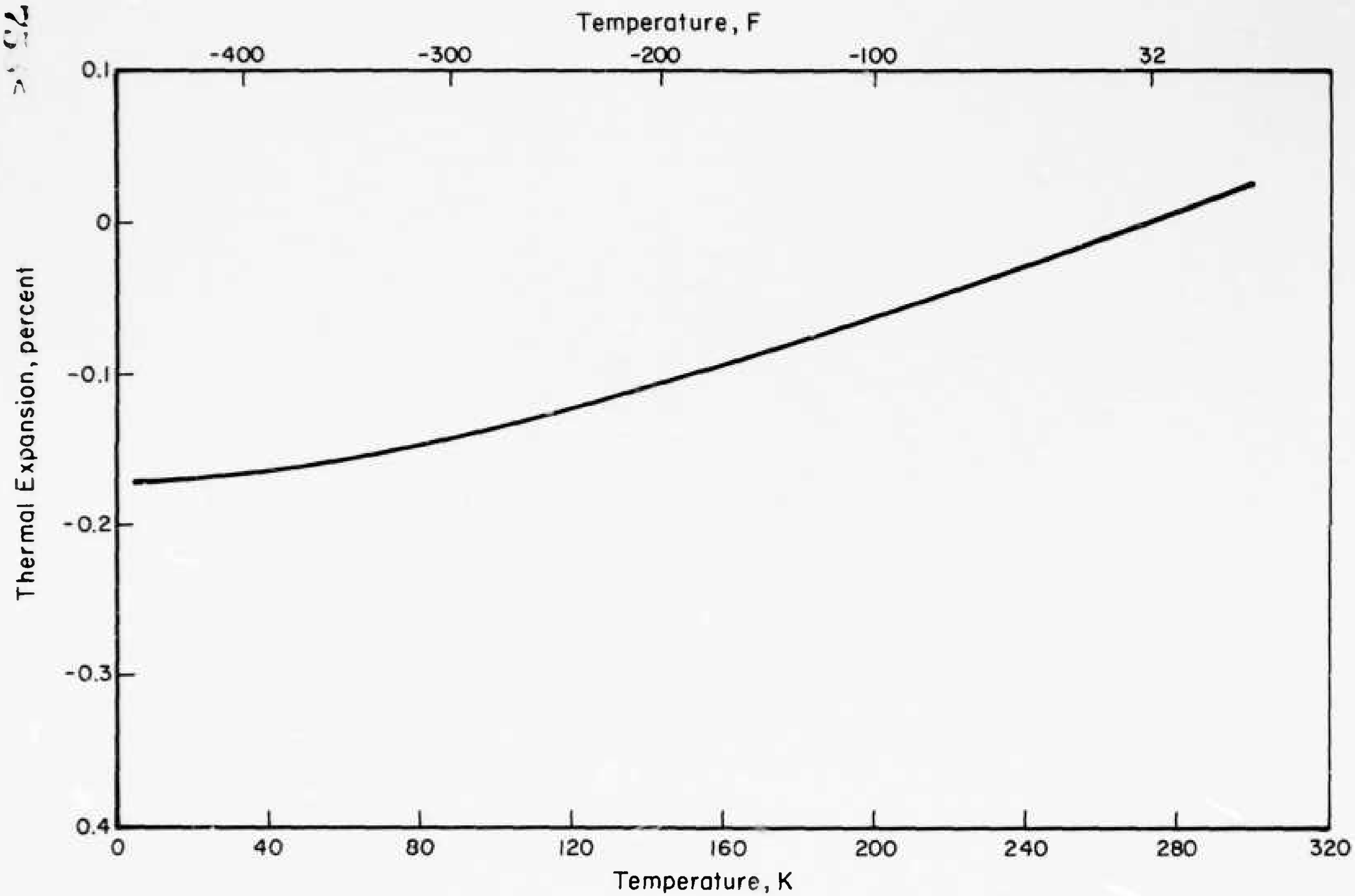

FIGURE 10.1.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Nb-48Ti ALLOY

TABLE 10.2.1-TR1

Alloy Designation: V_3Ga

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m^{-1} K^{-1}						
Btu hr^{-1} ft^{-1} F^{-1}						
No. of Spec.						
References:						
Thermal Expansion (T_{273} to T) Longitudinal						
Percent	0	-0.140	-0.162	-0.168	-0.169	0.169
No. of Spec.	1	1	1	1	1	1
References: 96878						
Specific Heat						
Joules kg^{-1} K^{-1}				18.96	5.813(n) 7.22 (s)	1.914(n) 0.196(s)
Btu lb^{-1} F^{-1}				(4.529×10^{-3})	[1.389×10^{-3}(n)] [1.73×10^{-3}(s)]	[4.57×10^{-4}(n)] [4.68×10^{-5}(s)]
No. of Spec.				1	1	1
References: 96876						
Electrical Resistivity						
Ohm m	185×10^{-8}	149×10^{-8}	139×10^{-8}	132×10^{-8}	129×10^{-8}	127×10^{-8}
Ohm circular mil ft^{-1}	(1110)	(896)	(836)	(794)	(776)	(764)
No. of Spec.	1	1	1	1	1	1
References: 96879						

(n) Normal State
(s) Superconducting State

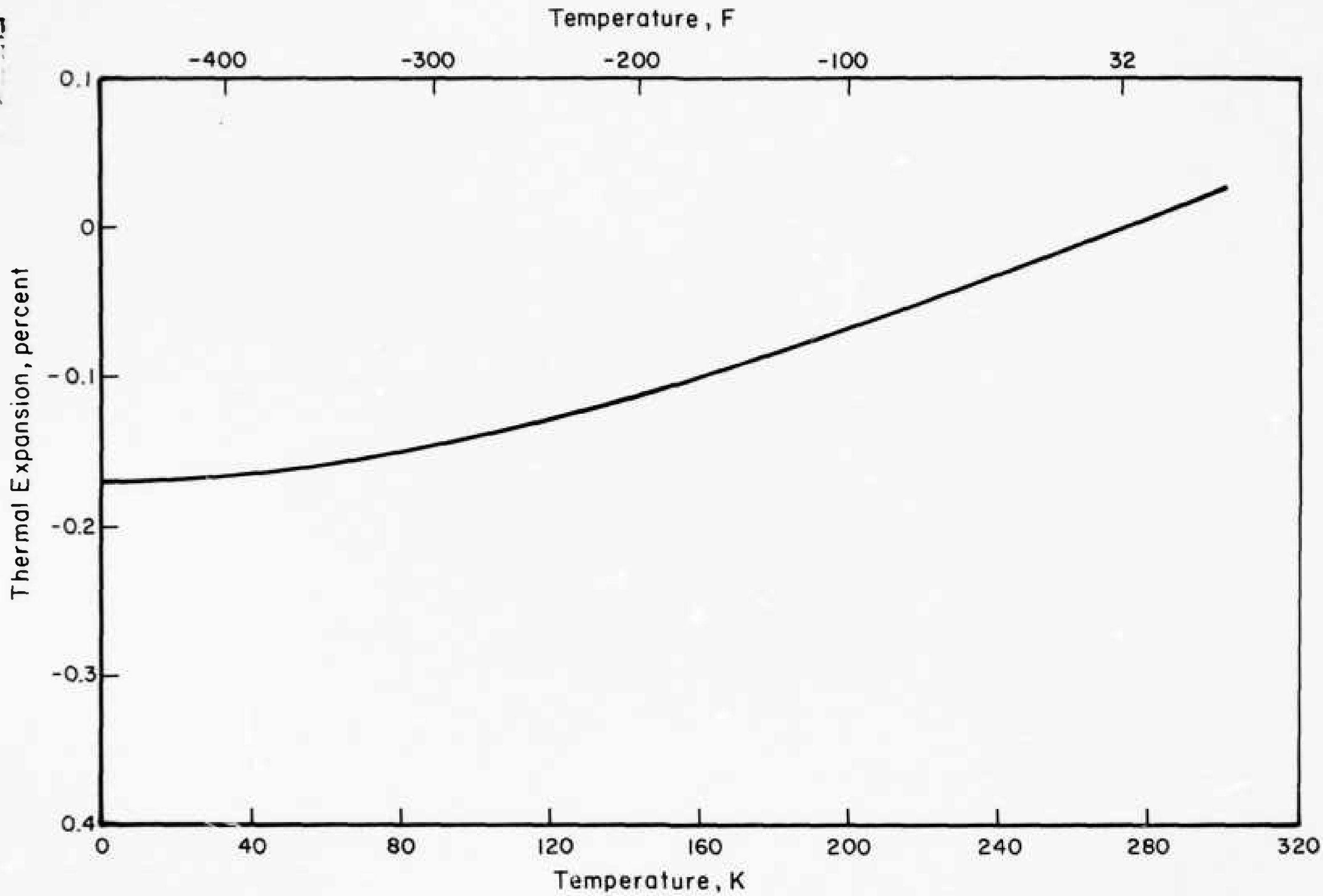

FIGURE 10.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR V_3Ga

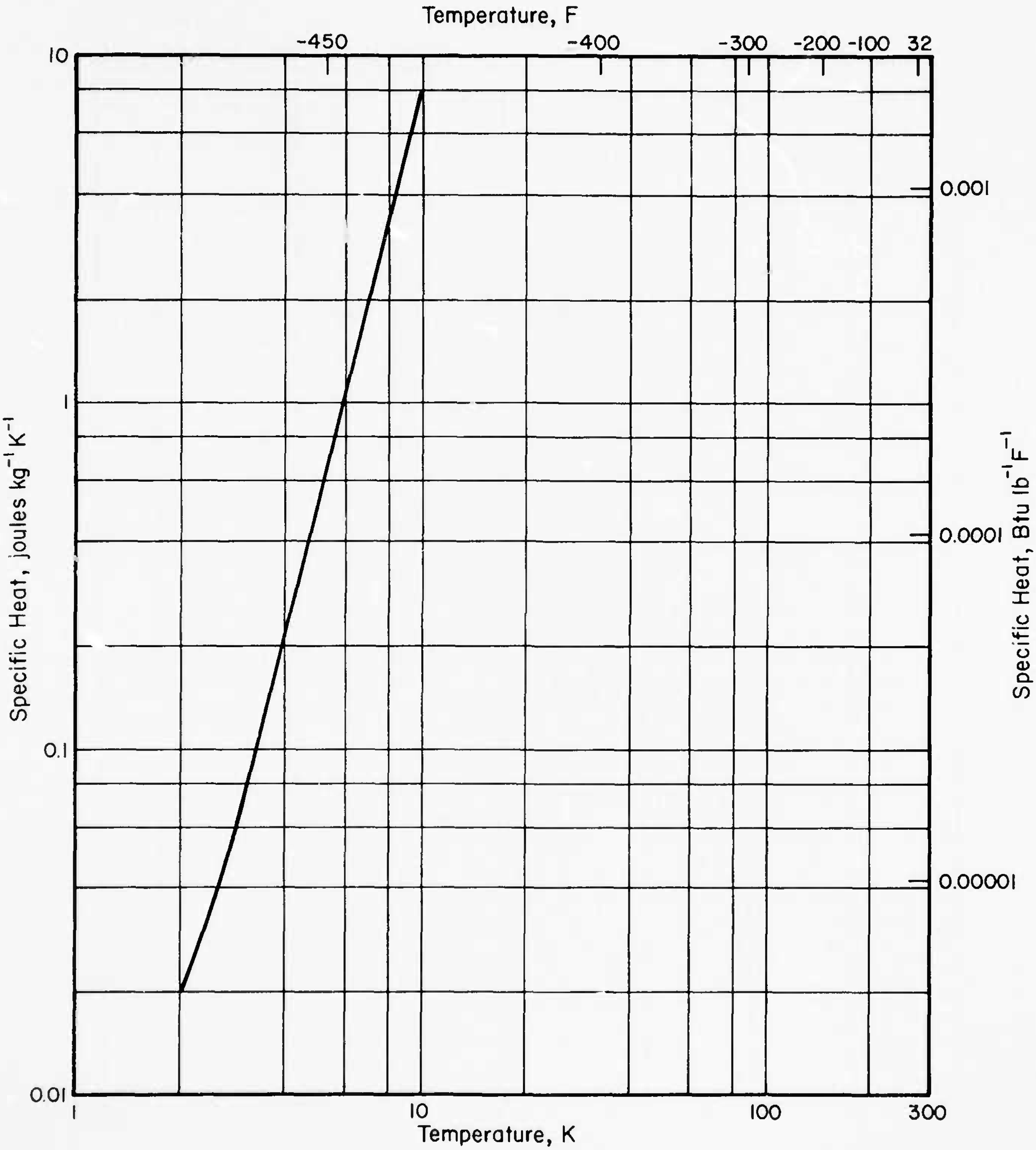

FIGURE 10.2.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR V_3Ga -- SUPERCONDUCTING STATE

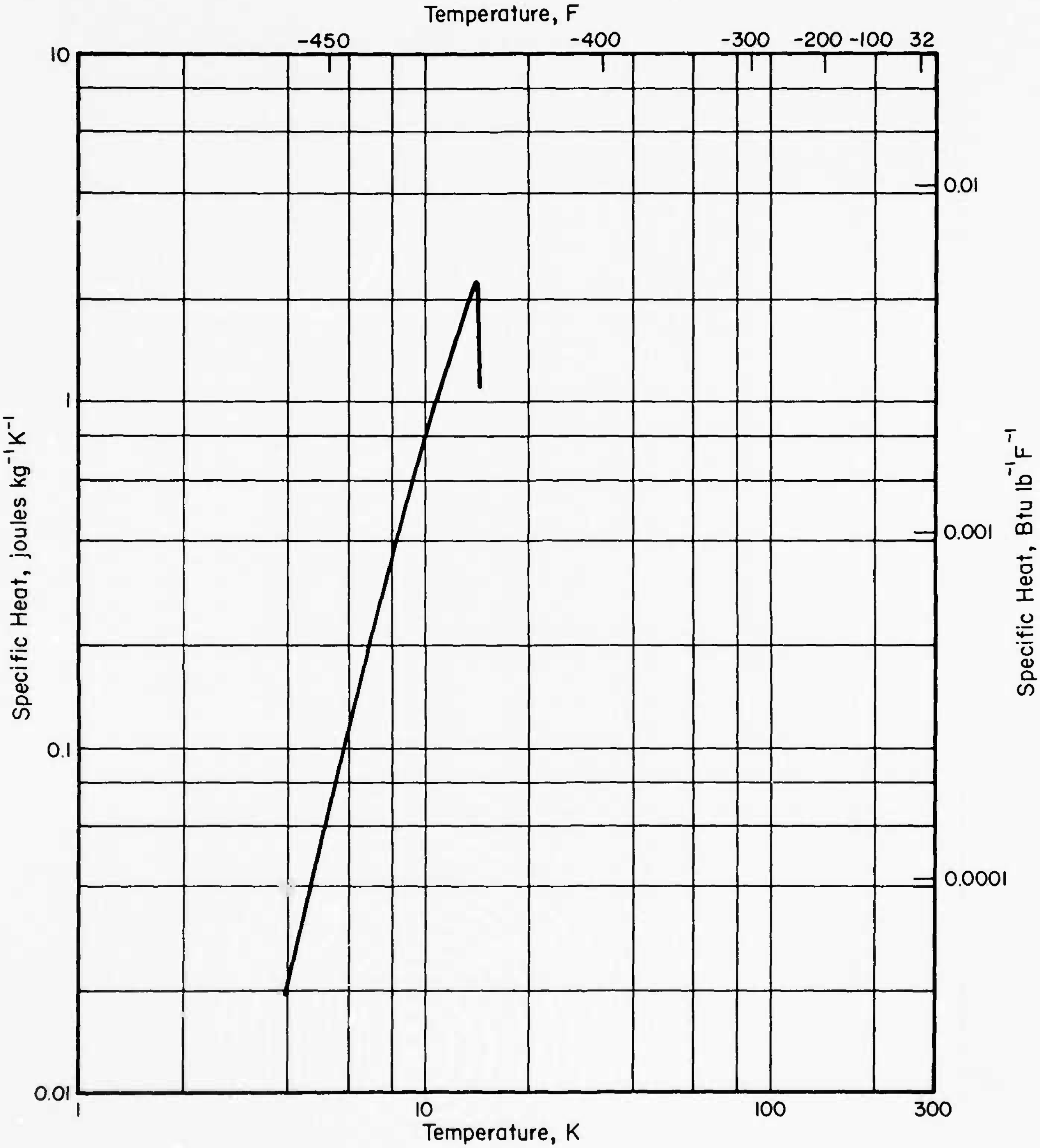

FIGURE 10.2.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR V_3Ga -- SUPERCONDUCTING STATE

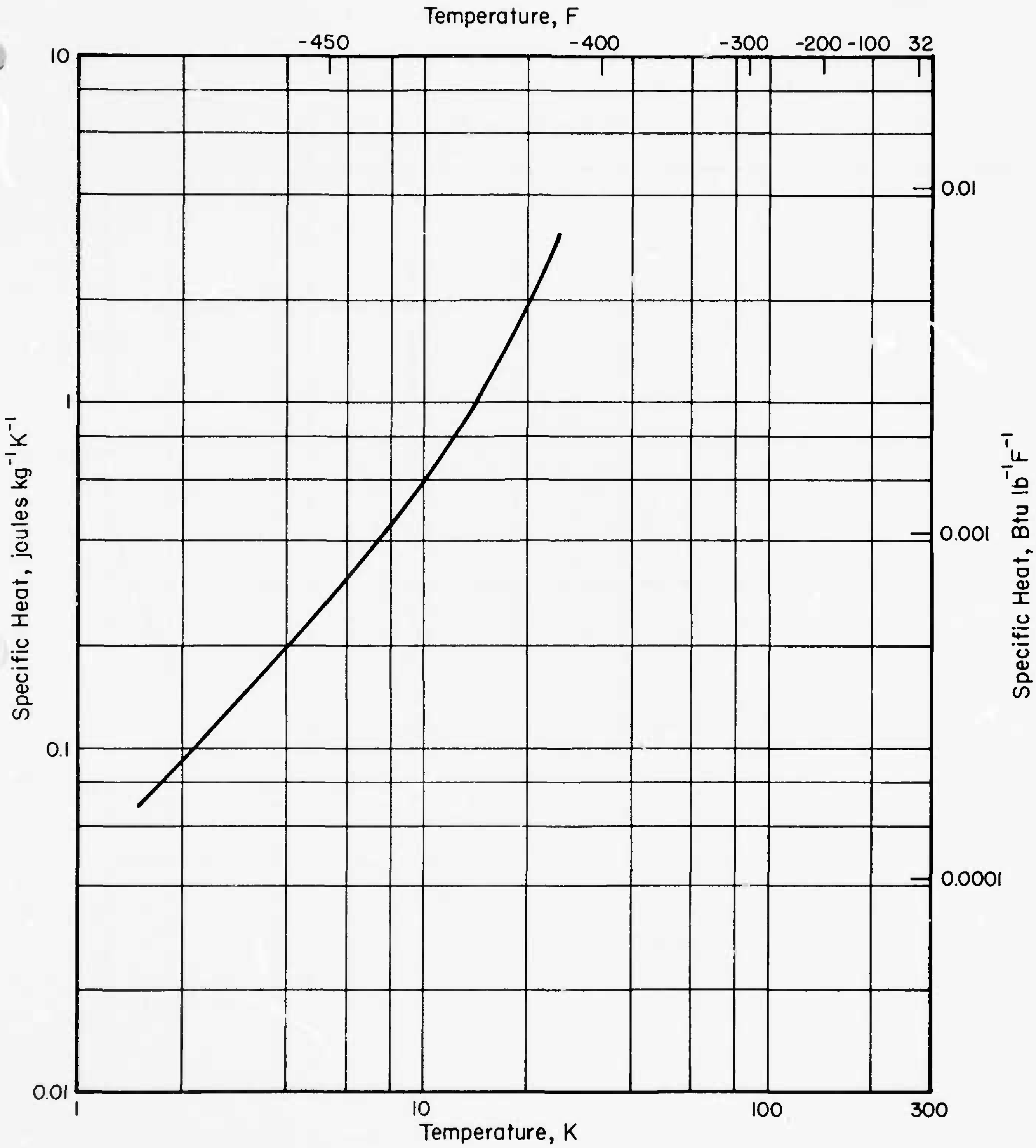

FIGURE 10.2.1-S3. SPECIFIC HEAT VERSUS TEMPERATURE FOR V_3Ga -- NORMAL STATE

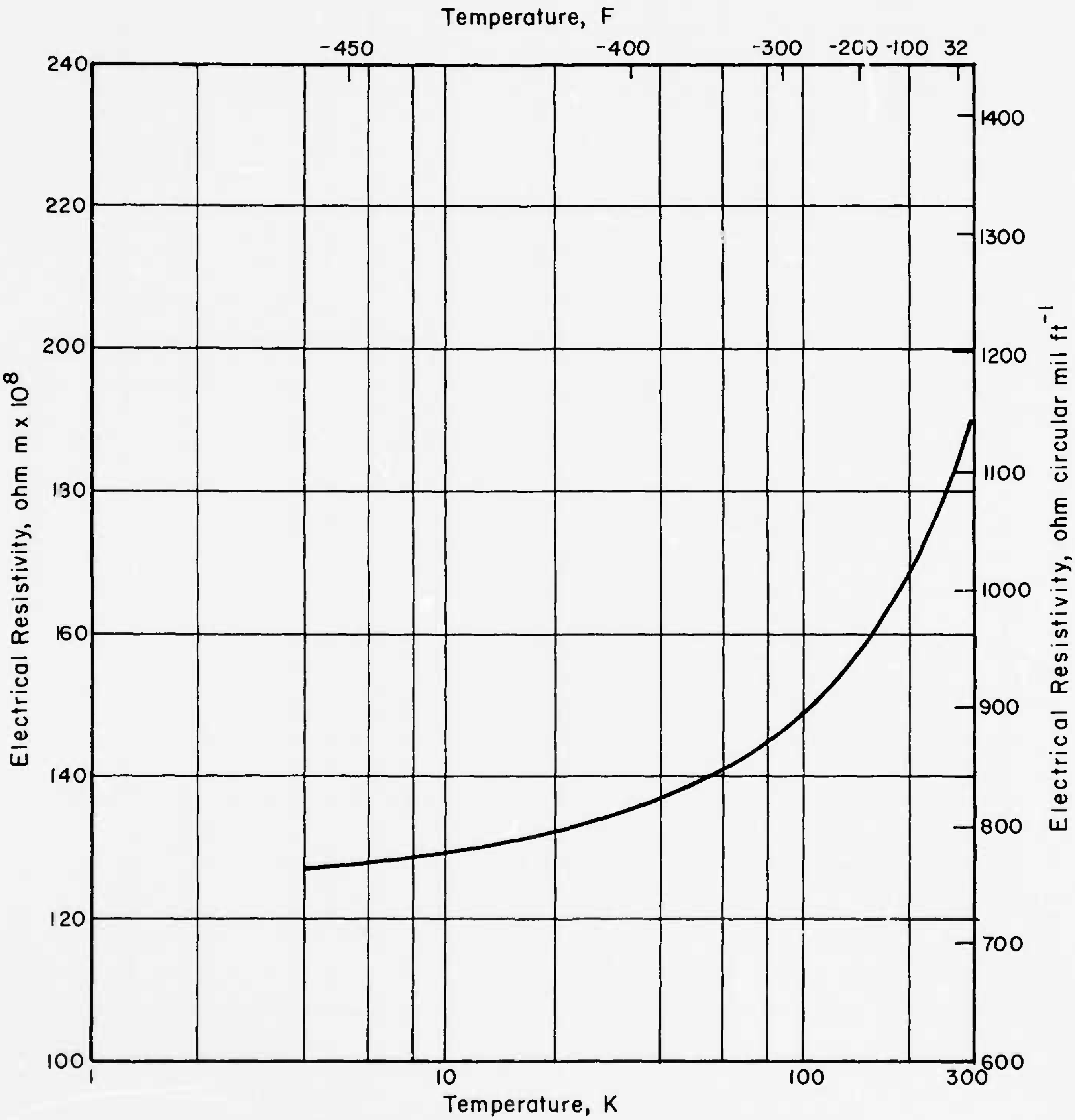

FIGURE 10.2.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR V_3Ga -- NORMAL STATE

TABLE 10.3.1-TR1

Alloy Designation: Magnesium Alloy AZ 31-B

Specification:
Form:
Dimension:
Condition:

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}(1)	72.0											
Btu hr^{-1} ft^{-1} F^{-1}		(4.16)										
No. of Spec	1											
References: 90224												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

(1) AN-M-29(approximately same composition as AZ 31-B

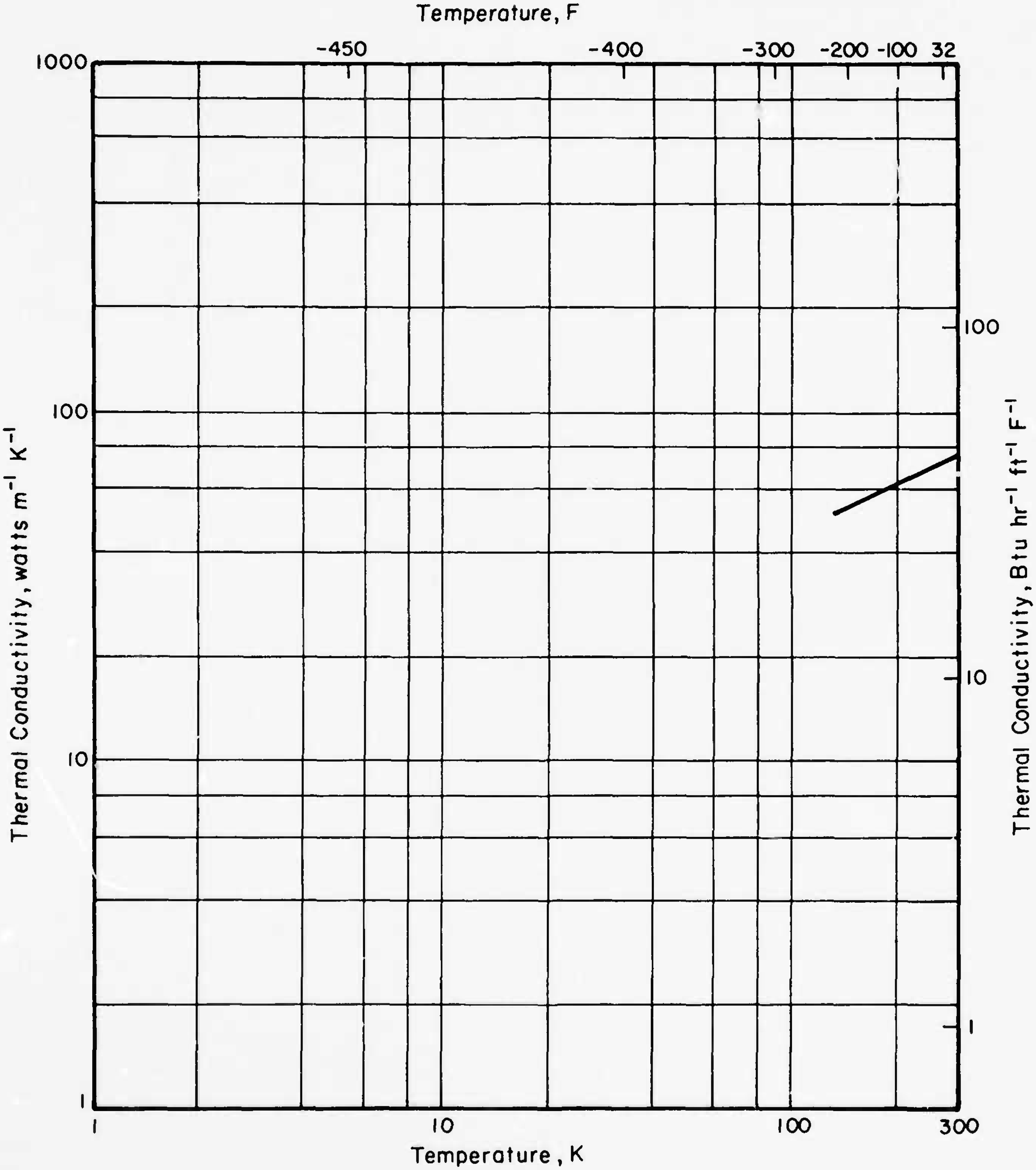

FIGURE 10.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR MAGNESIUM ALLOY AZ 31-B (AN-M-29)

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Alloy Designation:	Magnesium Alloys with Al and Mn
Specification:	
Form:	Not given
Dimension, cm(in.):	Not given
Condition:	Quenched from 475 C (887 F)

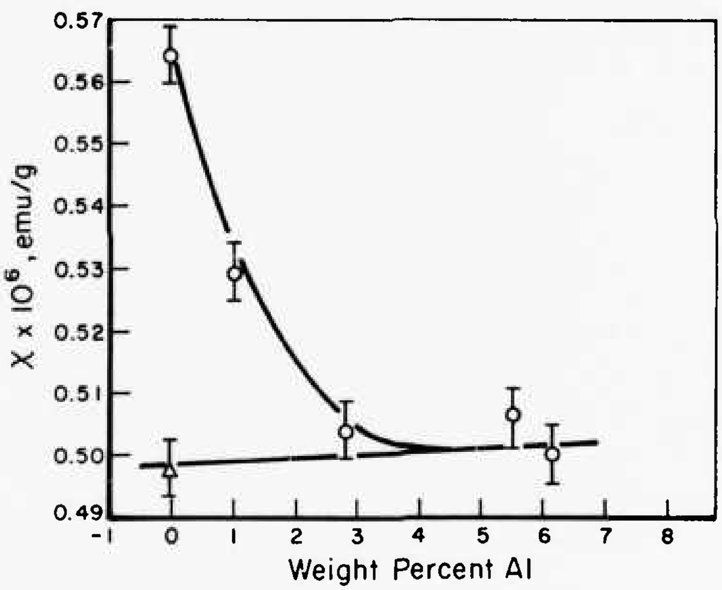


FIGURE 10.3.1-MA1. VALUES OF THE MASS SUSCEPTIBILITY, x_{cgsem}, FOR SEVERAL TERNARY AND BINARY ALLOYS OF MAGNESIUM. THE LOWER CURVE IS FOR THE BINARY ALLOYS WITH ALUMINUM, WHILE THE UPPER CURVE REPRESENTS THE ADDITION OF A FIXED CONCENTRATION OF MANGANESE OF APPROXIMATELY 0.04 WEIGHT PERCENT [96874]

INDEX TO MATERIAL CODES FOR SECTION 11.0

COMPOSITES

MATERIALS	MATERIAL CODE
GLASS-EPOXY	11.1.0
181/EPON 828	11.1.1
1581/E-787(58-68R)	11.1.2
S-901/NASA RESIN 2	11.1.3
BORON-EPOXY	11.2.0
4 MIL BORON/2387	11.2.1
5.6 MIL BORON/2387	11.2.2
GRAPHITE-EPOXY	11.3.0
AS/NASA RESIN 2	11.3.1
HT-S/X-904	11.3.2
BORON-ALUMINUM	11.4.0
5.6 MIL BORON/6061Al	11.4.1

TABLE 11.1.1-ME1

Composite Class: Glass-Epoxy Type: 181/Epon 828 (CL)

Specification:
Layup: Balance-weave cloth (57 x 54 count)
Nominal fiber volume fraction:
Nominal ply thickness: 0.254 mm (0.010 in.)

Fiber: S-994 with HTS finish
Matrix: Epon 828(CL)
Nominal density: 1.83 g/cm^3 (0.066 lbs/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)[a]							
TUS, MN/m^2 (ksi)	Avg	345 (50)	427 (62)	634 (92)	676 (98)		
	Min						
References: 15							
E_1, GN/m^2 (10^6 psi)	Avg	24.2 (3.51)	26.4 (3.83)	28.6 (4.15)	31.3 (4.54)		
	Min						
References: 15							
SE_1, MN/m^2 (ksi)	Avg	152 (22)	138 (20)	179 (26)	234 (34)		
	Min						
References: 15							
E_2 GN/m^2 (10^6 psi)	Avg	17.1 (2.48)	17.6 (2.56)	17.0 (2.47)	18.2 (2.64)		
	Min						
References: 15							
TPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg						
	Min						
References:							
Poisson's Ratio							
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
Tension, Transverse (90°)[b]							
TUS, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_1, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg						
	Min						
References:							
Poisson's Ratio							
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.

TABLE 11.1.1-ME2

Composite Class: Glass-Epoxy — Type: 181/Epon 828(CL)

Specification:
Layup: Balance-weave cloth (57 x 54 count)
Nominal fiber volume fraction:
Nominal ply thickness: 0.254 mm (0.010 in.)

Fiber: S-994 with HTS finish
Matrix: Epon 828(CL)
Nominal density: 1.83 g/cm^3 (0.066 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Compression, Longitudinal (0°)(a)											
CUS, MN/m^2 (ksi)	Max										
	Avg	300	(43.5)	589	(85.4)	758	(109.9)	750	(108.8)		
	Min										
References: 15											
CPL, MN/m^2 (ksi)	Max										
	Avg										
	Min										
References:											
E, GN/m^2 (10^6 psi)	Avg	23.1	(3.36)	22.9	(3.33)	28.0	(4.07)	29.4	(4.26)		
	Min										
References: 15											
Compression, Transverse (90°)(b)											
CUS, MN/m^2 (ksi)	Max										
	Avg										
	Min										
References:											
CPL, MN/m^2 (ksi)	Max										
	Avg										
	Min										
References:											
E, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
In-Plane Shear											
SUS, MN/m^2 (ksi)	Avg										
	Min										
References:											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
Interlaminar Shear											
SUS, MN/m^2 (ksi)	Avg										
	Min										
References:											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
Impact, Charpy V(Cv), Izod(I)											
Long., (0°) J (ft-lb)(a)	Avg										
	Min										
References:											
Trans., (90°) J (ft-lb)(b)	Avg										
	Min										
References:											
Sheet, Normal, J (ft-lb)(c)	Avg										
	Min										
References:											

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

Composite Class: Glass-Epoxy **Type:** 181/Epon 828(CL)

Specification:

Fiber: S-994 with HTS finish

Layup: Balance-weave cloth (57 x 54 count)

Matrix: Epon 828(CL)

Nominal fiber volume fraction:

Nominal density: 1.83 g/cm^3 (0.066 lb/in^3)

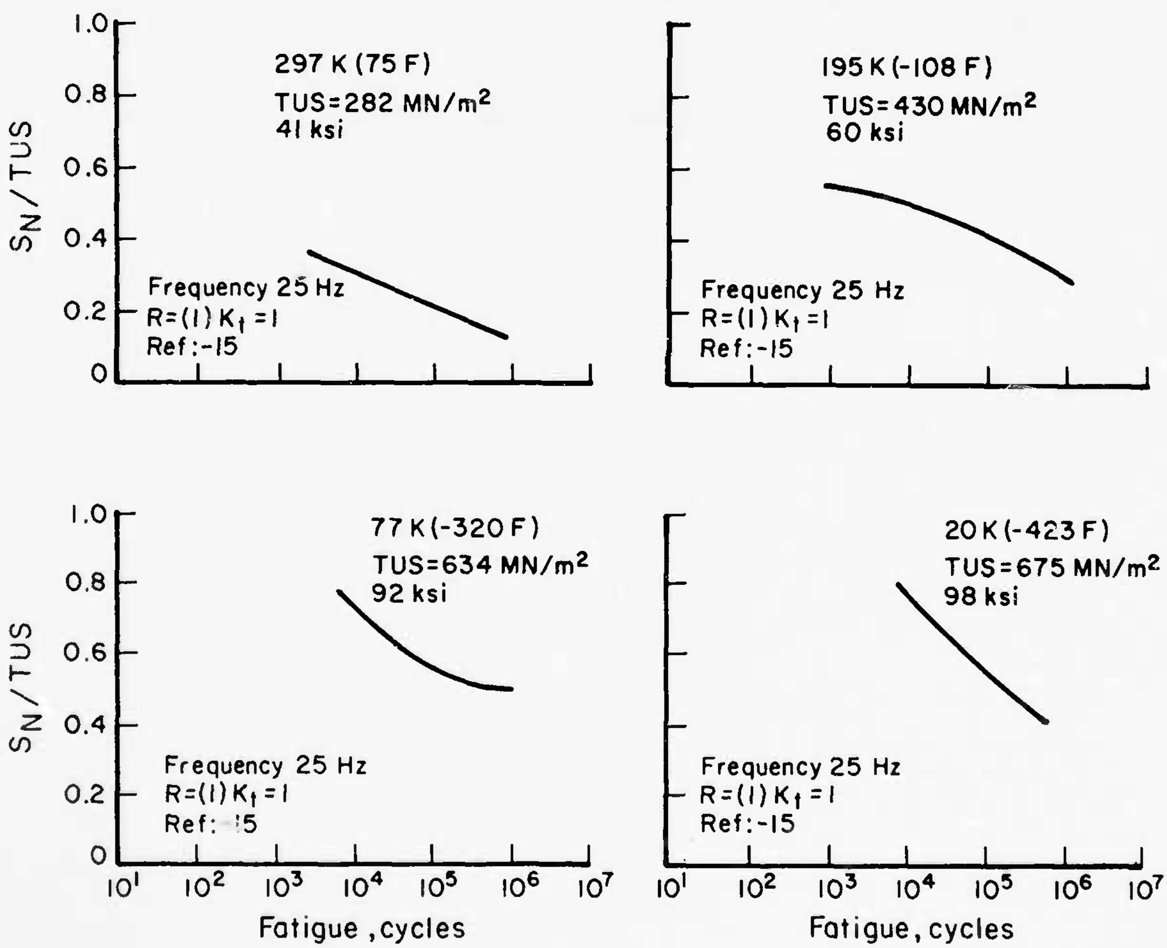
Nominal ply thickness: 0.254 mm (0.010 in.)

Comments:

Fatigue

Load orientation: parallel to warp or fill

Load direction: tension-tension



(1) Min. load 5% of tus.

FIGURE 11.1.1-ME1. FATIGUE LIFE CYCLE FOR GLASS-EPOXY

TABLE 11.1.1-TR1

Composite Class: Glass-Epoxy **Type:** 181/Epon 828(CL)

Specification:
Layup: Balance-weave cloth (57 x 54 count)
Nominal fiber volume fraction:
Nominal ply thickness: 0.254 mm (0.010 in.)

Fiber: S-994 with HTS finish
Matrix: Epon 828(CL)
Nominal density: 1.83 g/cm^3 (0.066 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)[a](1)							
Watts m^{-1} K^{-1}	Avg	0.50	0.44	0.26	0.20		
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.29	0.25	0.15	0.12		
References: 16							
Transverse (90°)[b](1)							
Watts m^{-1} K^{-1}	Avg	0.50	0.44	0.26	0.20		
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.29	0.25	0.15	0.16		
References: 16							
Sheet Normal[c](1)							
Watts m^{-1} K^{-1}	Avg	0.35	0.30	0.20	0.15		
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.20	0.17	0.12	0.087		
References: 16							
Thermal Expansion							
Longitudinal (0°)[a]							
10^{-6} $\Delta L/L$	Avg	0	-1300	-2700			
References: 17							
Transverse (90°)[b]							
10^{-6} $\Delta L/L$	Avg	0	-1300	-2700			
References. 17							
Sheet Normal[c]							
10^{-6} $\Delta L/L$	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1}(1)	Avg	880	640	240			
Btu lb^{-1} F^{-1}	Avg	2100	1500	580			
References: 16							
Electrical Resistivity							
Longitudinal (0°)[a]							
Ohm m	Avg						
References:							
Transverse (90°)[b]							
Ohm m	Avg						
References:							
Sheet Normal[c]							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.
(1) Nominal data for glass cloth-epoxy

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TABLE 11.1.2-ME1

Composite Class: Glass-Epoxy **Type:** 1581/E-787 (58-68R)

Specification:
Layup: Balance-weave cloth (57 x 54 count)
Nominal fiber volume fraction: 0.63
Nominal ply thickness: 0.216 mm (0.0085 in.)

Fiber: S-901
Matrix: E-787 (58-68R)
Nominal density: 1.769 g/cm^3 (0.064 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal (0°)[a]											
TUS, MN/m^2 (ksi)	Avg	634	(92)	793	(115)	999	(145)	951	(138)		
	Min	613	(89)	765	(111)	944	(137)	896	(130)		
References: 18											
E_1, GN/m^2 (10^6 psi)	Avg	22.7	(3.29)	24.1	(3.50)	26.8	(3.98)	29.4	(4.27)		
	Min	21.9	(3.18)	23.2	(3.37)	22.5	(3.26)	26.7	(3.88)		
References: 18											
SE_1, MN/m^2 (ksi)	Avg										
	Min										
References:											
E_2 GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
TPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
Failure Strain, 10^{-3}	Avg	33.7		41.1		50.1		48.1			
	Min	32.5		40.3		48.5		45.0			
References: 18											
Poisson's Ratio											
References:											
NTS, MN/m^2 (ksi)	Avg	489	(71)	607	(88)	786	(114)	813	(118)		
K_t = 3	Min	469	(68)	593	(86)	731	(106)	793	(115)		
References: 18											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
References:											
Tension, Transverse (90°)[b]											
TUS, MN/m^2 (ksi)	Avg	586	(85)	683	(99)	882	(128)	813	(118)		
	Min	558	(81)	620	(90)	862	(125)	806	(117)		
References: 18											
E_1, GN/m^2 (10^6 psi)	Avg	21.8	(3.17)	23.0	(3.34)	27.4	(3.97)	28.8	(4.18)		
	Min	21.6	(3.13)	22.5	(3.26)	26.6	(3.86)	27.8	(4.04)		
References: 18											
SE_1, MN/m^2 (ksi)	Avg										
	Min										
References:											
E_2, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
TPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
Failure Strain, 10^{-3}	Avg	33.0		39.6		46.4		44.5			
	Min	31.5		36.0		44.0		43.5			
References: 18											
Poisson's Ratio											
References:											
NTS, MN/m^2 (ksi)	Avg	469	(68)	558	(81)	689	(100)	723	(105)		
K_t =	Min	455	(66)	538	(78)	655	(95)	710	(103)		
References: 18											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
References:											

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.

TABLE 11.1.2-ME2

Composite Class: Glass-Epoxy **Type:** 1581/E-787 (58-68R)

Specification:
Layup: Balance-weave cloth (57 x 54 count)
Nominal fiber volume fraction: 0.63
Nominal ply thickness: 0.216 mm (0.0085 in.)

Fiber: S-901
Matrix: E-787 (58-68R)
Nominal density: 1.769 g/cm^3 (0.064 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)	
Compression, Longitudinal (0°)[a]												
CUS, MN/m^2 (ksi)	Max	476	(69)	600	(87)	745	(108)	807	(117)			
	Avg	434	(63)	552	(80)	710	(103)	751	(109)			
	Min	400	(58)	503	(73)	655	(95)	696	(101)			
References: 18												
CPL, MN/m^2 (ksi)	Max											
	Avg											
	Min											
References:												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
Compression, Transverse (90°)[b]												
CUS, MN/m^2 (ksi)	Max	421	(61)	565	(82)	717	(104)	738	(107)			
	Avg	414	(60)	510	(74)	648	(94)	689	(100)			
	Min	393	(57)	455	(66)	607	(88)	662	(96)			
References: 18												
CPL, MN/m^2 (ksi)	Max											
	Avg											
	Min											
References:												
E, GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
In-Plane Shear												
SUS, MN/m^2 (ksi)	Avg											
	Min											
References:												
SPL, MN/m^2 (ksi)	Avg											
	Min											
References:												
G, GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
Interlaminar Shear												
SUS, MN/m^2 (ksi)	Avg	54.4	(7.9)	68.9	(10.0)	89.6	(13.0)	77.2	(11.2)			
	Min	50.3	(7.3)	53.8	(7.8)	84.1	(12.2)	71.0	(10.3)			
References: 18												
SPL, MN/m^2 (ksi)	Avg											
	Min											
References:												
G, GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
Impact, Charpy V(Cv), Izod(I)												
Long., (0°) J (ft-lb)[a]	Avg											
	Min											
References:												
Trans., (90°) J (ft-lb)[b]	Avg											
	Min											
References:												
Sheet, Normal, J (ft-lb)[c]	Avg											
	Min											
References:												

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

TABLE 11.1.2-TR1

Composite Class: Glass-Epoxy | **Type: 1581/E-787 (58-68R)**

Specification:
Layup: Balance-weave cloth (57 x 54 count)
Nominal fiber volume fraction: 0.63
Nominal ply thickness: 0.216 mm (0.0085 in.)

Fiber: S-901
Matrix: E-787 (58-68R)
Nominal density: 1.769 g/cm^3 (0.064 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)[a] [1]							
Watts m^{-1} K^{-1}	Avg	0.50	0.44	0.26	0.20		
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.29	0.25	0.15	0.12		
References: 16							
Transverse (90°)[b] [1]							
Watts m^{-1} K^{-1}	Avg	0.50	0.44	0.26	0.20		
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.29	0.25	0.15	0.16		
References: 16							
Sheet Normal[c] [1]							
Watts m^{-1} K^{-1}	Avg	0.35	0.30	0.20	0.15		
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.20	0.17	0.12	0.087		
References: 16							
Thermal Expansion							
Longitudinal (0°)[a]							
10^{-6} ΔL/L	Avg	0	-1123	-2140	-2463	-2490	
References: 18							
Transverse (90°)[b]							
10^{-6} Δ L/L	Avg	0	-1077	-2033	-2323	-2343	
References: 18							
Sheet Normal[c]							
10^{-6} Δ L/L	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1} [1]	Avg	880	640	240			
Btu lb^{-1} F^{-1}	Avg	2100	1500	580			
References: 16							
Electrical Resistivity							
Longitudinal (0°)[a]							
Ohm m	Avg						
References:							
Transverse (90°)[b]							
Ohm m	Avg						
References:							
Sheet Normal[c]							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.
(1) Nominal data for glass cloth-epoxy.

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TABLE 11.1.3-ME1

Composite Class: Glass-Epoxy   **Type:** S-901/NASA Resin 2

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.6
Nominal ply thickness: 0.21 mm (0.083 in.)

Fiber: S-901
Matrix: NASA Resin 2[-11]
Nominal density: 2.9 g/cm^3 (0.07 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)	
Tension, Longitudinal (0°)[a]												
TUS, MN/m^2 (ksi)	Avg	1420	(206)			1953	(283)	1820	(264)	1937	(281)	
	Min	1192	(173)			1716	(249)	1606	(233)	1744	(253)	
References: 8, 10, 11												
E_1, GN/m^2 (10^6 psi)	Avg	58.7	(8.51)			62.8	(9.11)	77.9	(11.30)	60.1	(8.73)	
	Min	55.4	(8.05)			57.9	(8.40)	71.0	(10.30)	57.6	(8.35)	
References: 8, 10, 11												
SE_1, MN/m^2 (ksi)	Avg											
	Min											
References:												
E_2 GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
TPL, MN/m^2 (ksi)[1]	Avg											
	Min											
References:												
Failure Strain, 10^{-3}	Avg	28.0				31.5		24.0		30.3		
	Min	27.0				27.0		--		27.0		
References: 8, 10												
Poisson's Ratio		0.268				0.269				0.290		
References: 8												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
References:												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
References:												
Tension, Transverse (90°)[b]												
TUS, MN/m^2 (ksi)	Avg	46.9	(6.8)			93.7	(13.6)			78.6	(11.4)	
	Min	44.1	(6.4)			78.6	(11.4)			65.5	(9.5)	
References: 8												
E_1, GN/m^2 (10^6 psi)	Avg	12.4	(1.80)			21.2	(3.07)			22.0	(3.20)	
	Min	11.7	(1.69)			18.1	(2.63)			19.5	(2.82)	
References: 8												
SE_1, MN/m^2 (ksi)	Avg											
	Min											
References:												
E_2, GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
TPL, MN/m^2 (ksi)	Avg	13.8	(2.0)									
	Min	9.0	(1.3)									
References: 8												
Failure Strain, 10^{-3}	Avg	6.3				4.0				3.7		
	Min	5.0				3.0				3.0		
References: 8												
Poisson's Ratio		0.057				0.098				0.106		
References: 8												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
References:												
NTS, MN/m^2 (ksi)	Avg											
K_t =	Min											
References:												

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(1) Essentially linear to fracture.

TABLE 11.1.3-ME2

Composite Class: Glass-Epoxy **Type:** S-901/NASA Resin 2

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.6
Nominal ply thickness: 0.21 mm (0.0083 in.)

Fiber: S-901
Matrix: NASA Resin 2(-11)
Nominal density: 2.0 g/cm^3 (0.07 lb/in^3)
Comments:

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Compression, Longitudinal (0°)(a)											
CUS, MN/m^2 (ksi)	Max	562	(81.6)			1648	(239)			1544	(224)
	Avg	503	(73.0)			1356	(196)			1420	(206)
	Min	472	(68.5)			1034	(150)			1309	(190)
References: 8											
CPL, MN/m^2 (ksi)	Max					447	(64.8)			380	(55.2)
	Avg					313	(45.5)			312	(45.2)
	Min					178	(25.8)			243	(35.3)
References: 8											
E, GN/m^2 (10^6 psi)	Avg	50.6	(7.34)			63.6	(9.23)			60.5	(8.77)
	Min	40.5	(5.87)			48.3	(7.00)			53.8	(7.81)
References: 8											
Compression, Transverse (90°)(b)											
CUS, MN/m^2 (ksi)	Max	105	(15.3)			311	(45.1)			299	(43.4)
	Avg	98.6	(14.3)			276	(40.1)			262	(38.1)
	Min	93.8	(13.6)			234	(34.0)			213	(30.9)
References: 8											
CPL, MN/m^2 (ksi)	Max	55.0	(7.97)			131	(19.0)				
	Avg	45.0	(6.53)			114	(16.5)				
	Min	38.0	(5.51)			92	(13.4)				
References: 8											
E, GN/m^2 (10^6 psi)	Avg	11.3	(1.63)			22.8	(3.31)			31.3	(4.54)
	Min	9.8	(1.42)			19.8	(2.87)			27.2	(3.95)
References: 8											
In-Plane Shear											
SUS, MN/m^2 (ksi)	Avg										
	Min										
References:											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg	6.2	(0.90)			11.0	(1.60)			12.9	(1.87)
	Min	--				--				--	
References: 8											
Interlaminar Shear											
SUS, MN/m^2 (ksi)	Avg	29.8	(4.32)			64.3	(9.33)	61.0	(8.84)		
	Min	28.7	(4.16)			58.3	(8.45)	58.3	(8.46)		
References: 11											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
Impact, Charpy V(Cv), Izod(I)											
Long., (0°) J (ft-lb)(a)	Avg	111	(82)(I)			91	(67)(I)				
	Min	--				--					
References: 10											
Trans., (90°) J (ft-lb)(b)	Avg										
	Min										
References:											
Sheet, Normal, J (ft-lb)(c)	Avg										
	Min										
References:											

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

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TABLE 11.1.3-TR1

Composite Class: Glass-Epoxy — Type: S-901/NASA Resin 2

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.6
Nominal ply thickness: 0.21 mm (0.0083 in.)

Fiber: S-901
Matrix: NASA Resin 2(-11)
Nominal density: 2.0 g/cm^3 (0.07 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)(a)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Transverse (90°)(b)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Sheet Normal(c)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Thermal Expansion							
Longitudinal (0°)(a)							
10^{-6} ΔL/L	Avg	0	-260	-440	-480		
References: 11							
Transverse (90°)(b)							
10^{-6} ΔL/L	Avg	0	-2770	-3610	-4100		
References: 11							
Sheet Normal(c)							
10^{-6} ΔL/L	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1}	Avg						
Btu lb^{-1} F^{-1}	Avg						
References:							
Electrical Resistivity							
Longitudinal (0°)(a)							
Ohm m	Avg						
References:							
Transverse (90°)(b)							
Ohm m	Avg						
References:							
Sheet Normal(c)							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.

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TABLE 11.2.1-ME1

Composite Class: Boron-Epoxy **Type:** 4.0 mil Boron/2387

Specification: 5505/4
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.50
Nominal ply thickness: 0.132 mm (0.0052 in.)

Fiber: 4.0 mil boron on tungsten
Matrix: 2387
Nominal density: 2.006 g/cm^3 (0.0725 lb/in.^{3})
Comments: Specification SP-272 essentially equivalent properties (4.0 mil boron/PR-279)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)[a]							
TUS, MN/m^2 (ksi)	Avg	1427 (207)		1502 (218)	1406 (204)		
	Min	1296 (188)		1460 (212)	--		
References: 1, 2, 3							
E_1, GN/m^2 (10^6 psi)	Avg	206.8 (30)		220.6 (32)	227.5 (33)		
	Min	--		--	--		
References: 3							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2 GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi) (1)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg	6.41					
	Min	6.26					
References: 4, 5							
Poisson's Ratio		0.219					
References: 6							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
Tension, Transverse (90°)[b]							
TUS, MN/m^2 (ksi)	Avg	7.10 (10.30)	70.7 (10.25)	65.2 (9.46)	48.3 (7.00)		
	Min	62.0 (9.0)	--	62.0 (9.0)	--		
References: 1, 3							
E_1, GN/m^2 (10^6 psi)	Avg	20.3 (2.95)		32.4 (4.7)	34.5 (5.0)		
	Min	18.6 (2.70)					
References: 3, 4, 5							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg	23.4 (3.4)					
	Min	--					
References: 4, 5							
Failure Strain, 10^{-3}	Avg	4.49					
	Min	4.10					
References: 4, 5							
Poisson's Ratio		0.032					
References: 6							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(1) Essentially linear to fracture.

TABLE 11.2.1-ME2

Composite Class: Boron-Epoxy — Type: 4.0 mil Boron/2387

Specification: 5505/4
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.50
Nominal ply thickness: 0.132 mm (0.0052 in.)

Fiber: 4.0 mil boron on tungsten
Matrix: 2387
Nominal density: 2.006 g/cm^3 (0.0725 lb/in^3)
Comments: Specification SP-272 essentailly equivalent properties (4.0 mil boron/PR-279)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Compression, Longitudinal (0°)[a]							
CUS, MN/m^2 (ksi)	Max	2495 (362)		--	--		
	Avg	2456 (356)		3026 (439)	3736 (542)		
	Min	1820 (264)		--	--		
References: 3, 4, 5							
CPL, MN/m^2 (ksi)	Max	--					
	Avg	1530 (222)					
	Min	--					
References: 4, 5							
E, GN/m^2 (10^6 psi)	Avg	206 (30)		227 (33)	214 (31)		
	Min	193 (28)		--	--		
References: 3, 4, 5							
Compression, Transverse (90°)[b]							
CUS, MN/m^2 (ksi)	Max	310 (45)		--			
	Avg	283 (41)		524 (76)			
	Min	255 (37)		--			
References: 3, 4, 5							
CPL, MN/m^2 (ksi)	Max	--					
	Avg	100 (14.5)					
	Min	--					
References: 4							
E, GN/m^2 (10^6 psi)	Avg	22.4 (3.25)		40.0 (5.80)			
	Min	20.6 (3.00)		--			
References: 3, 4							
In-Plane Shear							
SUS, MN/m^2 (ksi)	Avg	131 (18.95)					
	Min	129 (18.70)					
References: 4							
SPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
G, GN/m^2 (10^6 psi)	Avg	6.41 (0.93)					
	Min	--					
References: 4							
Interlaminar Shear							
SUS, MN/m^2 (ksi)	Avg	95.1 (13.8)		120 (17.5)	138 (20)		
	Min	90.3 (13.1)		--	--		
References: 1, 2, 3							
SPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
Impact, Charpy V(Cv), Izod(I)							
Long., (0°) J (ft-lb)[a]	Avg						
	Min						
References:							
Trans., (90°) J (ft-lb)[b]	Avg						
	Min						
References:							
Sheet, Normal, J (ft-lb)[c]	Avg						
	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

Composite Class: Boron-Epoxy **Type:** 4.0 mil Boron/2387

Specification: 5505/4

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.50

Nominal ply thickness: 0.132 mm (0.0052 in.)

Fiber: 4.0 mil boron on tungsten

Matrix: 2387

Nominal density: 2.006 g/cm^3 (0.0725 lb/in.^{3})

Comments: Specification SP-272 essentially equivalent properties (4.0 mil boron/PR-279)

Fatigue

Load orientation: 0° (uniaxial)

Load direction: tension-tension

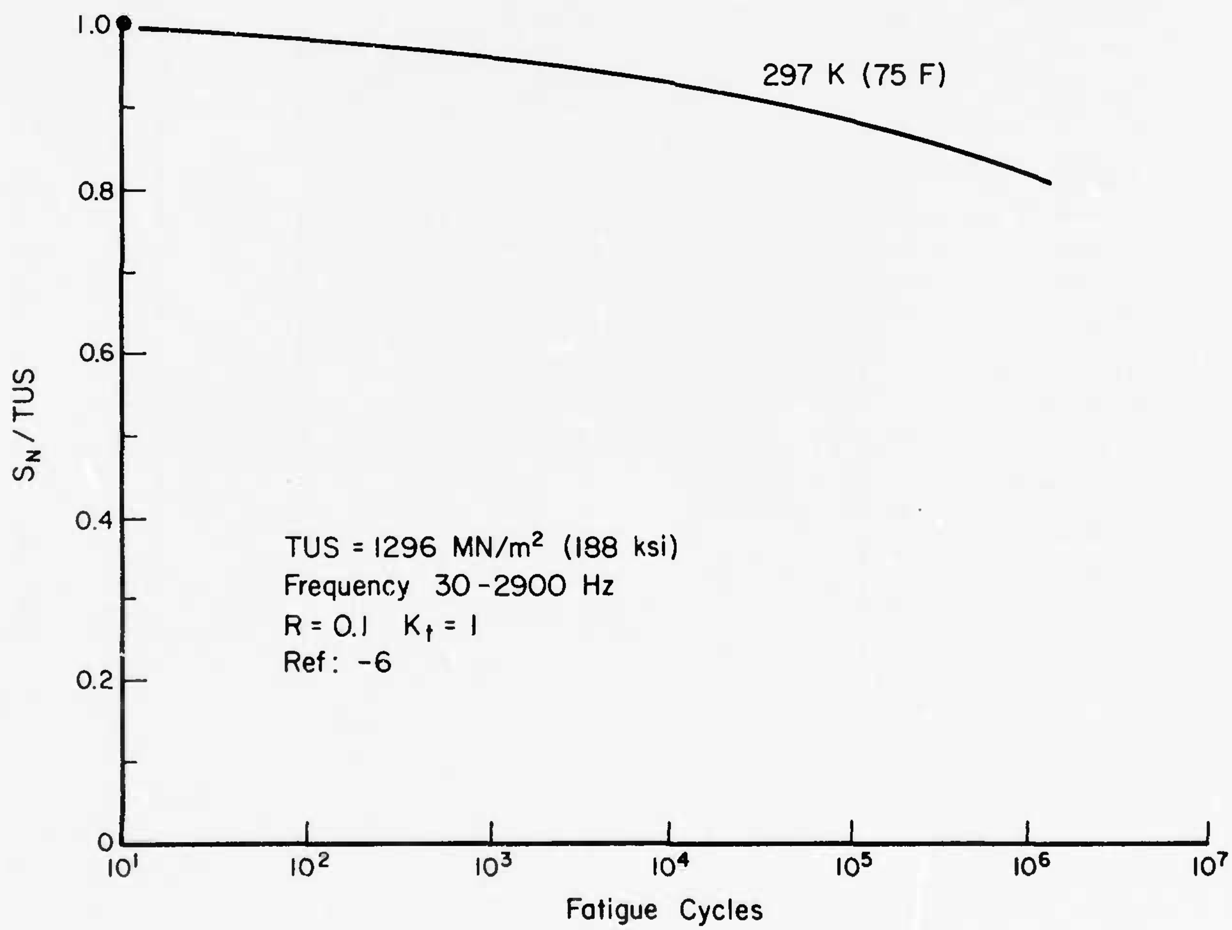

FIGURE 11.2.1-ME1. FATIGUE LIFE CYCLE FOR BORON-EPOXY

TABLE 11.2.1-TR1

Composite Class: Boron-Epoxy **Type:** 4.0 mil Boron/2387

Specification: 5505/4
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.50
Nominal ply thickness: 0.132 mm (0.0052 in.)

Fiber: 4.0 mil boron on tungsten
Matrix: 2387
Nominal density: 2.006 g/cm^3 (0.0725 lb/in.^{3})
Comments: Specification SP-272 essentially equivalent properties (4.0 mil boron/PR-279)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)(a)							
Watts m^{-1} K^{-1}	Avg	1.82	1.61	1.55			
Btu hr^{-1} ft^{-1} F^{-1}	Avg	1.05	0.93	0.89			
References: 1, 3							
Transverse (90°)(b)							
Watts m^{-1} K^{-1}	Avg	1.04	0.86	0.43			
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.6	0.5	0.27			
References: 3							
Sheet Normal(c)							
Watts m^{-1} K^{-1}	Avg	0.68	0.60	0.40			
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.39	0.35	0.23			
References: 1,3							
Thermal Expansion							
Longitudinal (0°)(a)							
10^{-6} $\Delta L/L$	Avg	0	-300	-460			
References: 1, 3							
Transverse (90°)(b)							
10^{-6} $\Delta L/L$	Avg	0	-1800	-2700			
References: 1, 3							
Sheet Normal(c)							
10^{-6} $\Delta L/L$	Avg	0	-1600	-2800			
References: 3							
Specific Heat							
Joules kg^{-1} K^{-1}	Avg	1150	700	325			
Btu lb^{-1} F^{-1}	Avg	2740	1670	776			
References: 1, 3							
Electrical Resistivity							
Longitudinal (0°)(a)							
Ohm m	Avg						
References:							
Transverse (90°)(b)							
Ohm m	Avg						
References:							
Sheet Normal(c)							
Ohm m	Avg	109					
References: 1							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.

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TABLE 11.2.2-ME1

Composite Class: Boron-Epoxy — Type: 5.6 mil Boron/2387

Specification: 5505/5.6
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.50
Nominal ply thickness: 0.1905 mm (0.0075 in.)

Fiber: 5.6 mil boron on tungsten
Matrix: 2387
Nominal density: 1.94 g/cm^3 (0.07 lb/in.^{3})
Comments: Specification SP-296 essentially equivalent properties (5.6 mil Boron/PR 286)

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal (0°)[a]											
TUS, MN/m^2 (ksi)	Avg	1630	(237)			1680	(243)			1820	(263)
	Min	1580	(229)			1610	(234)			1770	(257)
References: 7											
E_1, GN/m^2 (10^6 psi)	Avg	231	(33.5)			233	(33.9)			238	(34.5)
	Min	227	(32.9)			229	(33.2)			234	(34.0)
References: 7											
SE_1, MN/m^2 (ksi)	Avg										
	Min										
References:											
E_2 GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
TPL, MN/m^2 (ksi) (1)	Avg										
	Min										
References:											
Failure Strain, 10^{-3}	Avg	7.3				8.0				8.0	
	Min	7.0				7.0				8.0	
References: 7											
Poisson's Ratio 0.228		0.228				0.241				0.239	
References: 7											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
References:											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
References:											
Tension, Transverse (90°)[b]											
TUS, MN/m^2 (ksi)	Avg	47.0	(6.81)			49.0	(7.09)			41.4	(6.01)
	Min	43.4	(6.29)			45.2	(6.56)			30.3	(4.40)
References: 7											
E_1, GN/m^2 (10^6 psi)	Avg	17.5	(2.54)			31.2	(4.53)			35.8	(5.19)
	Min	16.3	(2.36)			28.9	(4.19)			33.9	(4.92)
References: 7											
SE_1, MN/m^2 (ksi)	Avg										
	Min										
References:											
E_2, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
TPL, MN/m^2 (ksi)(1)	Avg	34.4	(4.99)								
	Min	24.2	(3.50)								
References: 7											
Failure Strain, 10^{-3}	Avg	2.7				1.5				1.2	
	Min	2.0				1.0				1.1	
References: 7											
Poisson's Ratio		0.017				0.033				0.034	
References: 7											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
References:											
NTS, MN/m^2 (ksi)	Avg										
K_t =	Min										
References:											

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(1) Essentially linear to fracture.

TABLE 11.2.2-ME2

Composite Class: Boron-Epoxy **Type:** 5.6 mil Boron/2387

Specification: 5505/5.6
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.50
Nominal ply thickness: 0.1905 mm (0.0075 in.)

Fiber: 5.6 mil boron on tungsten
Matrix: 2387
Nominal density: 1.94 g/cm^3 (0.07 lb/in.^{3})
Comments: Specification SP-296 essentially equivalent properties (5.6 mil Boron/PR 286)

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Compression, Longitudinal (0°)[a]											
CUS, MN/m^2 (ksi)	Max									3660	(531)
	Avg									2723	(395)
	Min										
References:											
CPL, MN/m^2 (ksi) (1)	Max										
	Avg										
	Min										
References:											
E, GN/m^2 (10^6 psi)	Avg	214	(31)			228	(33)			241	(35)
	Min	--				--				--	
References: 8											
Compression, Transverse (90°)[b]											
CUS, MN/m^2 (ksi)	Max	223	(32.3)			456	(66.2)			452	(65.5)
	Avg	192	(27.9)			357	(54.5)			427	(62.0)
	Min	141	(20.5)			180	(26.1)			408	(59.2)
References: 8											
CPL, MN/m^2 (ksi) (1)	Max	97.2	(14.1)			338	(49.0)				
	Avg	71.6	(10.4)			241	(35.0)				
	Min	39.5	(5.7)			166	(24[illegible])				
References: 8											
E, GN/m^2 (10^6 psi)	Avg	19.3	(2.80)			39.2	(5.69)			40.3	(5.85)
	Min	13.3	(2.02)			37.7	(5.46)			37.8	(5.49)
References: 8											
In-Plane Shear											
SUS, MN/m^2 (ksi)	Avg										
	Min										
References:											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg	4.72	(0.68)			9.19	(1.33)			9.28	(1.35)
	Min	4.24	(0.62)			8.82	(1.28)			9.09	(1.32)
References: 7, 8											
Interlaminar Shear											
SUS, MN/m^2 (ksi)	Avg										
	Min										
References:											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
Impact, Charpy V(Cv), Izod(I)											
Long., (0°) J (ft-lb)[a]	Avg										
	Min										
References:											
Trans., (90°) J (ft-lb)[b]	Avg										
	Min										
References:											
Sheet, Normal, J (ft-lb)[c]	Avg										
	Min										
References:											

77.3<

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.
(1) Essentially linear to fracture.

TABLE 11.2.2-TR1

Composite Class: Boron-Epoxy — **Type:** 5.6 mil Boron/2387

Specification: 5505/5.6
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.50
Nominal ply thickness: 0.1905 mm (0.0075 in.)

Fiber: 5.6 mil boron on tungsten
Matrix: 2387
Nominal density: 1.94 g/cm^3 (0.07 lb/in.^{3})
Comments: Specification SP-296 essentially equivalent properties (5.6 mil Boron/PR 286)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)[a]							
Watts m^{-1} K^{-1}	Avg	1.02	1.11	0.913 (82 K)		0.178 (7.8 K)	
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.59	0.64	0.528 (82 K)		0.103 (7.8 K)	
References: 9							
Transverse (90°)[b]							
Watts m^{-1} K^{-1}	Avg	0.581	0.553	0.466 (86.7 K)		0.174 (14.7 K)	
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.336	0.320	0.269 (86.7 K)		0.100 (14.7 K)	
References: 9							
Sheet Normal[c]							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Thermal Expansion							
Longitudinal (0°)[a]							
10^{-6} $\Delta L/L$	Avg						
References:							
Transverse (90°)[b]							
10^{-6} $\Delta L/L$	Avg						
References:							
Sheet Normal[c]							
10^{-6} $\Delta L/L$	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1}	Avg						
Btu lb^{-1} F^{-1}	Avg						
References:							
Electrical Resistivity							
Longitudinal (0°)[a]							
Ohm m	Avg						
References:							
Transverse (90°)[b]							
Ohm m	Avg						
References:							
Sheet Normal[c]							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.

TABLE 11.3.1-ME1

Composite Class: Graphite-Epoxy **Type:** AS/NASA Resin 2

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.6
Nominal ply thickness: 0.207 mm (0.008 in.)
Fiber: Type AS graphite
Matrix: NASA Resin 2(-11)
Nominal density: 1.52 g/cm^3 (0.055 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)[a]							
TUS, MN/m^2 (ksi)	Avg	1300 (190)		1230 (178)		1300 (190)	
	Min	1190 (173)		1213 (176)		1260 (183)	
References: 8							
E_1, GN/m^2 (10^6 psi)[2]	Avg	117 (17.0)		101 (14.7)		116 (16.9)	
	Min	112 (16.3)		94 (13.6)		107 (15.5)	
References: 8							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2 GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)[1]	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg	9.3		9.3		9.0	
	Min	9.0		9.0		9.0	
References: 8							
Poisson's Ratio		0.347		0.299		0.340	
References: 8							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
Tension, Transverse (90°)[b]							
TUS, MN/m^2 (ksi)	Avg	12.8 (1.86)		2.44 (0.354)		3.04 (0.441)	
	Min	10.1 (1.47)		1.62 (0.235)		2.37 (0.344)	
References: 8							
E_1, GN/m^2 (10^6 psi)	Avg	7.79 (1.13)		10.90 (1.58)		11.25 (1.63)	
	Min	7.10 (1.03)		9.65 (1.40)		10.34 (1.50)	
References: 8							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)[1]	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg	2.0		0.2		0.3	
	Min	2.0		0.2		0.2	
References: 8							
Poisson's Ratio		0.022		0.030		0.029	
References: 8							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(1) Essentially linear to fracture.
(2) Secondary modulus detected 7-14 GN/m^2 (1-2 x 10^6) higher.

TABLE 11.3.1-ME2

Composite Class: Graphite-Epoxy | **Type:** AS/NASA Resin 2

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.6
Nominal ply thickness: 0.207 mm (0.008 in.)

Fiber: Type AS graphite
Matrix: NASA Resin 2(-11)
Nominal density: 1.52 g/cm^3 (0.055 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)
Compression, Longitudinal (0°)[a]											
CUS, MN/m^2 (ksi)	Max	561	(81.2)			1229	(178)			883	(128)
	Avg	531	(77.0)			897	(130)			694	(100)
	Min	496	(71.9)			668	(97)			600	(87)
References: 8											
CPL, MN/m^2 (ksi)	Max	355	(51.5)			504	(73.1)			377	(54.7)
	Avg	283	(41.0)			450	(65.4)			374	(54.2)
	Min	225	(32.6)			395	(57.3)			370	(53.7)
References: 8											
E, GN/m^2 (10^6 psi)	Avg	129	(18.7)			122	(17.7)			125	(18.1)
	Min	125	(18.1)			110	(16.0)			124	(18.0)
References: 8											
Compression, Transverse (90°)[b]											
CUS, MN/m^2 (ksi)	Max	104	(15.1)			151	(21.9)			150	(21.8)
	Avg	89	(12.8)			136	(19.8)			130	(19.0)
	Min	71	(10.3)			125	(18.1)			100	(14.4)
References: 8											
CPL, MN/m^2 (ksi)	Max					116	(16.8)			72	(10.5)
	Avg					95	(13.8)			68	(9.8)
	Min					80	(11.5)			65	(9.4)
References: 8											
E, GN/m^2 (10^6 psi)	Avg	11.0	(1.59)			15.3	(2.21)			16.1	(2.34)
	Min	10.8	(1.57)			13.1	(1.89)			14.4	([illegible].09)
References: 8											
In-Plane Shear											
SUS, MN/m^2 (ksi)	Avg	4.14	(0.60)			4.48	(0.65)			5.30	(0.77)
	Min	--				--				--	
References: 7											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
Interlaminar Shear											
SUS, MN/m^2 (ksi)	Avg										
	Min										
References:											
SPL, MN/m^2 (ksi)	Avg										
	Min										
References:											
G, GN/m^2 (10^6 psi)	Avg										
	Min										
References:											
Impact, Charpy V(Cv), Izod(I)											
Long., (0°) J (ft-lb)[a]	Avg										
	Min										
References:											
Trans., (90°) J (ft-lb)[b]	Avg										
	Min										
References:											
Sheet, Normal, J (ft-lb)[c]	Avg										
	Min										
References:											

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

TABLE 11.3.2-ME1

Composite Class: Graphite-Epoxy Type: HT-S/X-904

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.60
Nominal ply thickness: 0.127 mm (0.005 in.)

Fiber: HT-S
Matrix: X-904
Nominal density: 1.65 g/cm^3 (0.0595 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)[(a)]							
TUS, MN/m^2 (ksi)	Avg	1296 (188)		1013 (147)			
	Min	--		--			
References: 1							
E_1, GN/m^2 (10^6 psi)	Avg	138 (20.0)		140 (20.3)			
	Min	--		--			
References: 1							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2 GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg	9.0		7.3			
	Min	--		--			
References: 1							
Poisson's Ratio		0.32		0.35			
References: 1							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
Tension, Transverse (90°)[(b)]							
TUS, MN/m^2 (ksi)	Avg	16.5 (2.4)		24.1 (3.5)			
	Min	--		--			
References: 1							
E_1, GN/m^2 (10^6 psi)	Avg	7.86 (1.14)		10.96 (1.59)			
	Min	--		--			
References: 1							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg	2.0		2.1			
	Min	--		--			
References: 1							
Poisson's Ratio		0.01		0.02			
References: 1							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.

TABLE 11.3.2-ME2

Composite Class: Graphite-Epoxy **Type:** HT-S/X-904

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.60
Nominal ply thickness: 0.127 mm (0.005 in.)

Fiber: HT-S
Matrix: X-904
Nominal density: 1.65 g/cm^3 (0.0595 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Compression, Longitudinal (0°)[a]							
CUS, MN/m^2 (ksi)	Max	--		--			
	Avg	787 (114)		1371 (199)			
	Min	--		--			
References: 1							
CPL, MN/m^2 (ksi)	Max						
	Avg						
	Min						
References:							
E, GN/m^2 (10^6 psi)	Avg	136 (19.8)		128 (18.6)			
	Min	--		--			
References: 1							
Compression, Transverse (90°)[b]							
CUS, MN/m^2 (ksi)	Max	--		--			
	Avg	150 (21.8)		253 (36.7)			
	Min	--		--			
References: 1							
CPL, MN/m^2 (ksi)	Max						
	Avg						
	Min						
References:							
E, GN/m^2 (10^6 psi)	Avg	10.4 (1.51)		17.2 (2.50)			
	Min	--		--			
References: 1							
In-Plane Shear							
SUS, MN/m^2 (ksi)	Avg						
	Min						
References:							
SPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
Interlaminar Shear							
SUS, MN/m^2 (ksi)	Avg	95.8 (13.9)		120 (17.4)			
	Min						
References: 1							
SPL, MN/m^2 (ksi)	Avg						
	Min						
References:							
G, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
Impact, Charpy V(Cv), Izod(I)							
Long., (0°) J (ft-lb)[a]	Avg						
	Min						
References:							
Trans., (90°) J (ft-lb)[b]	Avg						
	Min						
References:							
Sheet, Normal, J (ft-lb)[c]	Avg						
	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.

TABLE 11.3.2-TR1

Composite Class: Graphite-Epoxy Type: HT-S/X-904

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.60
Nominal ply thickness: 0.127 mm (0.005 in.)

Fiber: HT-S
Matrix: X-904
Nominal density: 1.65 g/cm^3 (0.0595 lb/in.^{3})
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)[(a)]							
Watts m^{-1} K^{-1}	Avg	13.55	11.50	4.30			
Btu hr^{-1} ft^{-1} F^{-1}	Avg	7.83	6.64	2.48			
References: 1							
Transverse (90°)[(b)]							
Watts m^{-1} K^{-1}	Avg	0.660	0.505	0.267			
Btu hr^{-1} ft^{-1} F^{-1}	Avg	0.381	0.291	0.154			
References: 1							
Sheet Normal[(c)]							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Thermal Expansion							
Longitudinal (0°)[(a)]							
10^{-6} $\Delta L/L$	Avg	0	+13.9	+41.6			
References: 1							
Transverse (90°)[(b)]							
10^{-6} $\Delta L/L$	Avg	0	-1270	-2500			
References: 1							
Sheet Normal[(c)]							
10^{-6} $\Delta L/L$	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1}	Avg	890	629	304			
Btu lb^{-1} F^{-1}	Avg	2125	1492	726			
References: 1							
Electrical Resistivity							
Longitudinal (0°)[(a)]							
Ohm m	Avg	0.3-70*		0.4-90*			
References: 1							
Transverse (90°)[(b)]							
Ohm m	Avg	190		220			
References: 1							
Sheet Normal[(c)]							
Ohm m	Avg	1600		1900			
References: 1							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.
* Electrical resistivity in fiber direction strongly affected by fiber volume, fiber distribution and moisture content of composite.

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TABLE 11.4.1-ME1

Composite Class: Boron-Aluminum   **Type:** 5.6 mil Boron/6061

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.47
Nominal ply thickness: 0.180 mm (0.007 in.)

Fiber: 5.6 mil boron on tungsten
Matrix: 6061 Aluminum
Nominal density: 2.66 g/cm^3 (0.096 lb/in.^{3})
Comments: F Temper, diffusion bonded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)[a]							
TUS, MN/m^2 (ksi)	Avg	1310 (190)		1630 (237)		1606 (233)	
	Min	1206 (175)		1585 (230)		1496 (217)	
References: 6, 7							
E_1, GN/m^2 (10^6 psi)	Avg	205 (29.8)		196 (28.5)		204 (29.5)	
	Min	194 (28.1)		186 (27.0)		191 (27.7)	
References: 6, 7							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2 GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)[1]	Avg						
	Min						
References:							
Failure Strain, 10^{-3}	Avg	6.20		7.75		7.75	
	Min	6.00		7.00		7.00	
References: 6, 7							
Poisson's Ratio		0.29		0.34		0.34	
References: 6, 7							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
Tension, Transverse (90°)[b]							
TUS, MN/m^2 (ksi)	Avg	163 (23.6)		244 (35.4)		276 (40.0)	
	Min	145 (21.1)		229 (33.2)		273 (39.6)	
References: 6, 7							
E_1, GN/m^2 (10^6 psi)	Avg	156 (22.6)		123 (18.5)		150 (21.8)	
	Min	138 (20.0)		100 (14.6)		118 (17.1)	
References: 6, 7							
SE_1, MN/m^2 (ksi)	Avg						
	Min						
References:							
E_2, GN/m^2 (10^6 psi)	Avg						
	Min						
References:							
TPL, MN/m^2 (ksi)	Avg	66.2 (9.6)		76.0 (11.0)		72.1 (10.5)	
	Min	53.7 (7.8)		64.8 (9.4)		50.3 (7.3)	
References: 6, 7							
Failure Strain, 10^{-3}	Avg	6.3		8.3		8.7	
	Min	4.9		8.0		8.0	
References: 6, 7							
Poisson's Ratio		0.22		0.22		0.25	
References: 6, 7							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							
NTS, MN/m^2 (ksi)	Avg						
K_t =	Min						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(1) Essentially linear to fracture.

TABLE 11.4.1-ME2

Composite Class: Boron-Aluminum   Type: 5.6 mil Boron/6061

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.47
Nominal ply thickness: 0.180 mm (0.007 in.)

Fiber: 5.6 mil boron on tungsten
Matrix: 6061 Aluminum
Nominal density: 2.66 g/cm^3 (0.095 lb/in.^{3})
Comments: F Temper, diffusion bonded

Testing Temperature, K (F)		297	(75)	195	(-108)	77	(-320)	20	(-423)	4	(-452)	
Compression, Longitudinal (0°)[a]												
CUS, MN/m^2 (ksi)[1]	Max	2475	(359)			2868	(416)			3260	(473)	
	Avg	1980	(287)			2068	(300)			2900	(421)	
	Min	1455	(211)			1393	(202)			2600	(377)	
References: 8, 12, 13												
CPL, MN/m^2 (ksi)[2]	Max											
	Avg											
	Min											
References:												
E, GN/m^2 (10^6 psi)[1, 3]	Avg	(228)	(33)									
	Min		--									
References: 6												
Compression, Transverse (90°)[b]												
CUS, MN/m^2 (ksi)[1]	Max	321	(46.6)			456	(66.2)			656	(95.1)	
	Avg	275	(39.8)			436	(63.2)			623	(90.3)	
	Min	249	(36.1)			387	(56.1)			582	(84.5)	
References: 8, 12, 13												
CPL, MN/m^2 (ksi)[1]	Max	59.4	(8.61)			96.7	(14.0)			113	(16.4)	
	Avg	57.7	(8.37)			87.3	(12.7)			108	(15.7)	
	Min	54.9	(7.97)			81.8	(11.9)			101	(14.6)	
References: 8												
E, GN/m^2 (10^6 psi)[1]	Avg	150	(21.8)			124	(18.0)			101	(14.6)	
	Min	107	(15.5)			89	(12.9)			90	(13.0)	
References: 8, 12, 13												
In-Plane Shear												
SUS, MN/m^2 (ksi)	Avg	155	(22.5)			162	(23.5)					
	Min	89	(12.9)			137	(19.8)					
References: 12												
SPL, MN/m^2 (ksi)	Avg											
	Min											
References:												
G, GN/m^2 (10^6 psi)	Avg	58	(8.4)									
	Min	57	(8.3)									
References: 12												
Interlaminar Shear												
SUS, MN/m^2 (ksi)	Avg	124	(18)			132	(19.1)					
	Min	97	(14)				--					
References: 6, 14												
SPL, MN/m^2 (ksi)	Avg											
	Min											
References:												
G, GN/m^2 (10^6 psi)	Avg											
	Min											
References:												
Impact, Charpy V(Cv), Izod(I)												
Long., (0°) J (ft-lb)[a]	Avg											
	Min											
References:												
Trans., (90°) J (ft-lb)[b]	Avg											
	Min											
References:												
Sheet, Normal, J (ft-lb)[c]	Avg											
	Min											
References:												

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.
(1) Sandwich beam data not included.
(2) Essentially linear to fracture.
(3) 297 K data may be used conservatively at low temperatures.

Composite Class: Boron-Aluminum **Type:** 5.6 mil Boron/6061

Specification:

Fiber: 5.6 mil boron on tungsten

Layup: Uniaxial tape

Matrix: 6061 aluminum

Nominal fiber volume fraction: 0.47

Nominal density: 2.66 g/cm^3 (0.095 lb/in.^{3})

Nominal ply thickness: 0.180 mm (0.007 in.)

Comments: F Temper, diffusion bonded

Fatigue

Load orientation: 0° (uniaxial)

Load direction: tension-tension

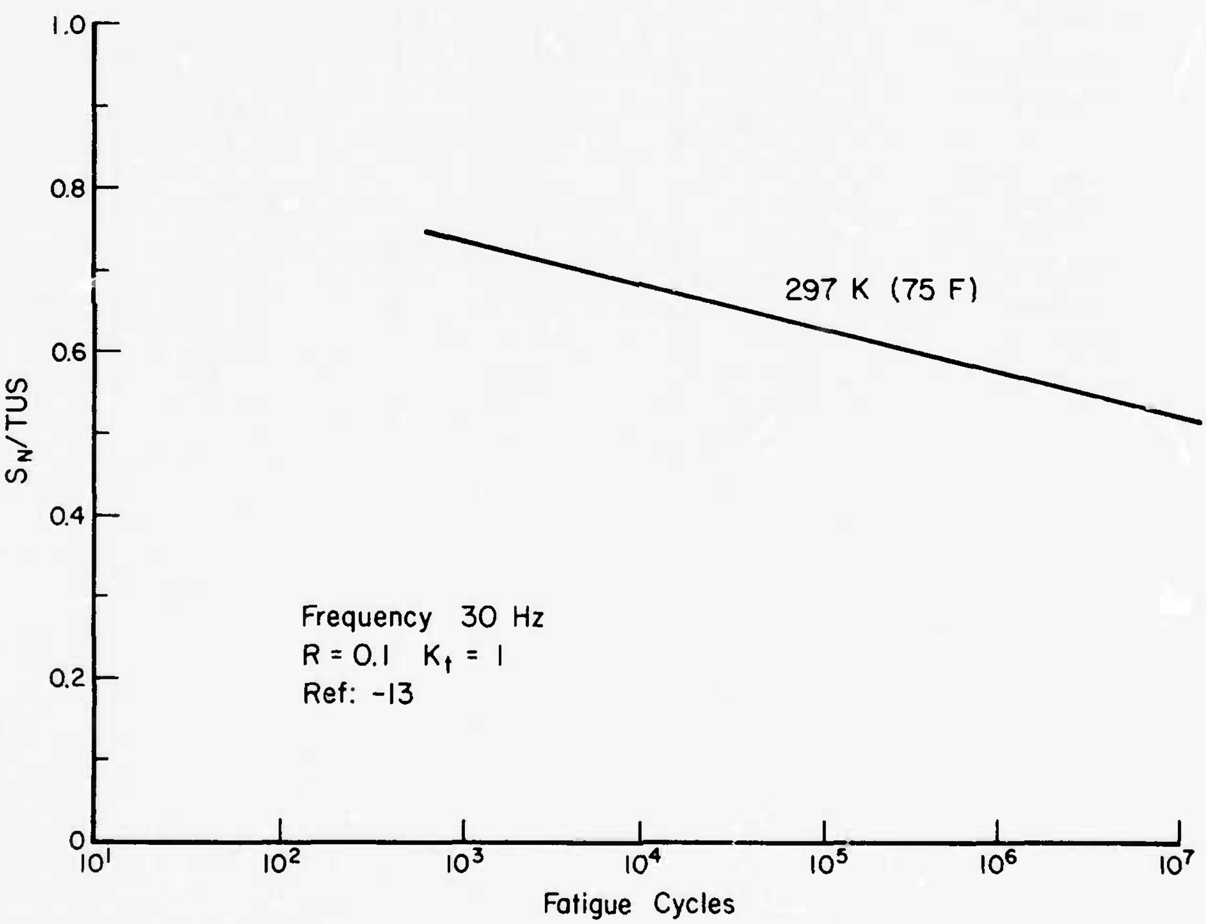

FIGURE 11.4.1-ME1. FATIGUE LIFE CYCLE FOR BORON-ALUMINUM

TABLE 11.4.1-TR1

Composite Class: Boron-Aluminum Type: 5.6 mil Boron/6061

Specification:
Layup: Uniaxial tape
Nominal fiber volume fraction: 0.47
Nominal ply thickness: 0.180 mm (0.007 in.)

Fiber: 5.6 mil boron on tungsten
Matrix: 6061 Aluminum
Nominal density: 2.66 g/cm^3 (0.095 lb/in.^{3})
Comments: F Temper, diffusion bonded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)(a)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Transverse (90°)(b)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Sheet Normal(c)							
Watts m^{-1} K^{-1}	Avg						
Btu hr^{-1} ft^{-1} F^{-1}	Avg						
References:							
Thermal Expansion							
Longitudinal (0°)(a)							
10^{-5} ΔL/L	Avg	0		-460		-740	
References: 1,14							
Transverse (90°)(b)							
10^{-6} Δ L/L	Avg	0		-2240		-3380	
References: 1, 14							
Sheet Normal(c)							
10^{-6} Δ L/L	Avg						
References:							
Specific Heat							
Joules kg^{-1} K^{-1}	Avg	984		440			
Btu lb^{-1} F^{-1}	Avg	2350		1050			
References: 14							
Electrical Resistivity							
Longitudinal (0°)(a)							
Ohm m	Avg						
References:							
Transverse (90°)(b)							
Ohm m	Avg						
References:							
Sheet Normal(c)							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.
(b) Fill direction in woven cltoh.
(c) Press cure direction.

78.[illegible]

References

1. Hertz, J., Christian, J. L., and Varlas, M., "Advanced Composite Applications for Spacecraft and Missiles, Phase I Final Report, Vol. II: Material Development", AFML-TR 71-186, Vol. 2 (March 1972) AD 893715L.

2. Hertz, J., "Investigation into the High-Temperature Strength Degradation of Fiber-Reinforced Resin Composites During Ambient Aging", General Dynamics/Convair Report No. GDCA-DBG73-005 (June 1973).

3. Nadler, M. A., Yoshino, S. Y., and Darms, F. J., "Boron/Epoxy Support Strut for Non-Integral Cryogenic Tankage", North American Rockwell Space Division Report SD 68-99501 (February 1969).

4. Kaminski, B. E., Lemon, G. H., and McKague, E. L., "Development of Engineering Data for Advanced Composite Materials-Vol. 1, Static and Thermo Physical Properties", AFML-TR 70-108 (October 1972).

5. "Development of Engineering Data on the Mechanical and Physical Properties of Advanced Composite Materials", AFML-TR 72-205, Part I (September 1972).

6. "Advanced Composites Design Guide, 3rd Ed., Vol. IV: Materials", AFML, Wright-Patterson AFB, Ohio (January 1973).

7. "Materials Research for Super Conducting Machinery", Semi-Annual Technical Report IV, Advanced Research Projects Agency (1975).

8. Unpublished data, Cryogenic Division, National Bureau of Standards, Boulder, Colorado.

9. Hust, J. G., "Thermal Conductivity of Transverse and Longitudinal Boron-Epoxy", Cryogenics Division-NBS Institute for Basic Standards Laboratory Note 75-4 (August 1, 1975).

10. Lewis, A. and Bush, G. E., "Improved Cryogenic Resin-Glass Filament-Wound Composites", NASA CR-72163 (March 1967) N67-31856.

11. Soffer, L. M. and Molho, R., "Cryogenic Resins for Glass Filament-Wound Composites", NASA CR-72114 (January 1967) N67-25076.

12. Miller, M. F., Christian, J. L., and Wenhold, W. F., "Design, Manufacture, Development, Test and Evaluation of Boron/Aluminum for Space Shuttle Components", NAS 8-27738, General Dynamics/Convair Report GDCA-DBG 73-06 (August 1973).

13. Hofer, K. E., Jr., Reo, N., and Larsen, D., "Development of Engineering Data on the Mechanical and Physical Properties of Advanced Composite Materials", AFML-TR 72-205, Part II, AFML, WPAFB, Ohio (February 1974).

14. Christian, J. L. and Campbell, M. D., "Mechanical and Physical Properties of Several Advanced Metal-Matrix Composite Materials", Advances in Cryogenic Engineering, Vol. 18, K. D. Timmerhaus, Ed., Plenum Press, New York (1973), p. 175.

15. Brink, N. O., "Determination of the Performance of Plastic Laminates Under Cryogenic Temperatures", ASD-TDR-62-794, Air Force Systems Command, WPAFB, Ohio (August 1962) AD 288944.

16. Kasen, M. B., "Mechanical and Thermal Properties of Filamentary-Reinforced Structural Composites at Cryogenic Temperatures-I: Glass-Reinforced Composites", Cryogenics J., Vol. 15, (N06) (June 1975), p.327.

17. Steinhauer, R. A., "Linear Thermal Expansion of 828CL 181 Cloth Laminate", Douglas Aircraft Company, M&P Lab Report MP 11, 979 (August 1961).

18. Toth, L. W., Boller, T. J., Butcher, I. R., Kariotis, A. H., and Yoder, F. D., "Program for the Evaluation of Structural Reinforced Plastic Materials at Cryogenic Temperatures", NASA CR-80061 (Final), George C. Marshall Space Flight Center, Huntsville, Alabama (August 1966) N67-12051.

INDEX TO MATERIAL CODES FOR SECTION 12.0

POLYMERS

MATERIALS	MATERIAL CODE
POLYETHYLENE (PE)	12.1.1
POLYTETRAFLUOROETHYLENE (PTFE)	12.1.2
POLYCHLOROTRIFLUOROETHYLENE (PCTFE)	12.1.3
POLYMETHYLMETHACRYLATE (PMM)	12.2.1
POLYSTYRENE (PS)	12.3.1
POLYVINYLACETATE (PVA)	12.4.1

TABLE 12.1.2-ME5

Alloy Designation: Polychlorotrifluoroethylene (PCTFE)

Specification:
Form:
Thickness, cm (in.):
Condition:
Crystallinity, percent: 67.6-70.0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
E_{f1}, GN/m^2 (10^6 psi)	Avg						
	Min						
E_{f2}, GN/m^2 (10^6 psi)	Avg						
	Min						
No. of Spec.							
Impact							
Charpy, V, J (ft-lb)J/m	Avg						
(ft-lb/in.)	Min						
No. of Spec.							
No. of Spec							
Izod, J/m (ft-lb/in.)	Avg	58.2 (1.10)	55.5 (1.05)		58.2 (1.10)	65.6 (1.24)	
	Min	51.8 (0.93)	52.9 (1.00)		52.9 (1.00)	59.2 (1.12)	
No. of Spec.							
Hardness							
Rockwell	Avg						
	Min						

References: 90205

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TABLE 12.1.2-TR1

Alloy Designation: Polychlorotrifluoroethylene (Kel-F)

Specification:
Form:
Dimension:
Condition: Amorphous

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}	0.130		0.09[illegible]		0.079		0.054		0.038		0.0190	
Btu hr^{-1} ft^{-1} F^{-1}		(0.075)		(0.057)		(0.046)		(0.031)		(0.022)		(0.011)
No. of Spec.	1		1		1		1		1		1	
References: 90205, 96881												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-0.725		-0.860							
No. of Spec.	1		1		1							
References: 94202												
Specific Heat												
Joules kg^{-1} K^{-1}											3.72	
Btu lb^{-1} F^{-1}												(9.56×10^{-4})
No. of Spec.											1	
References: 96881												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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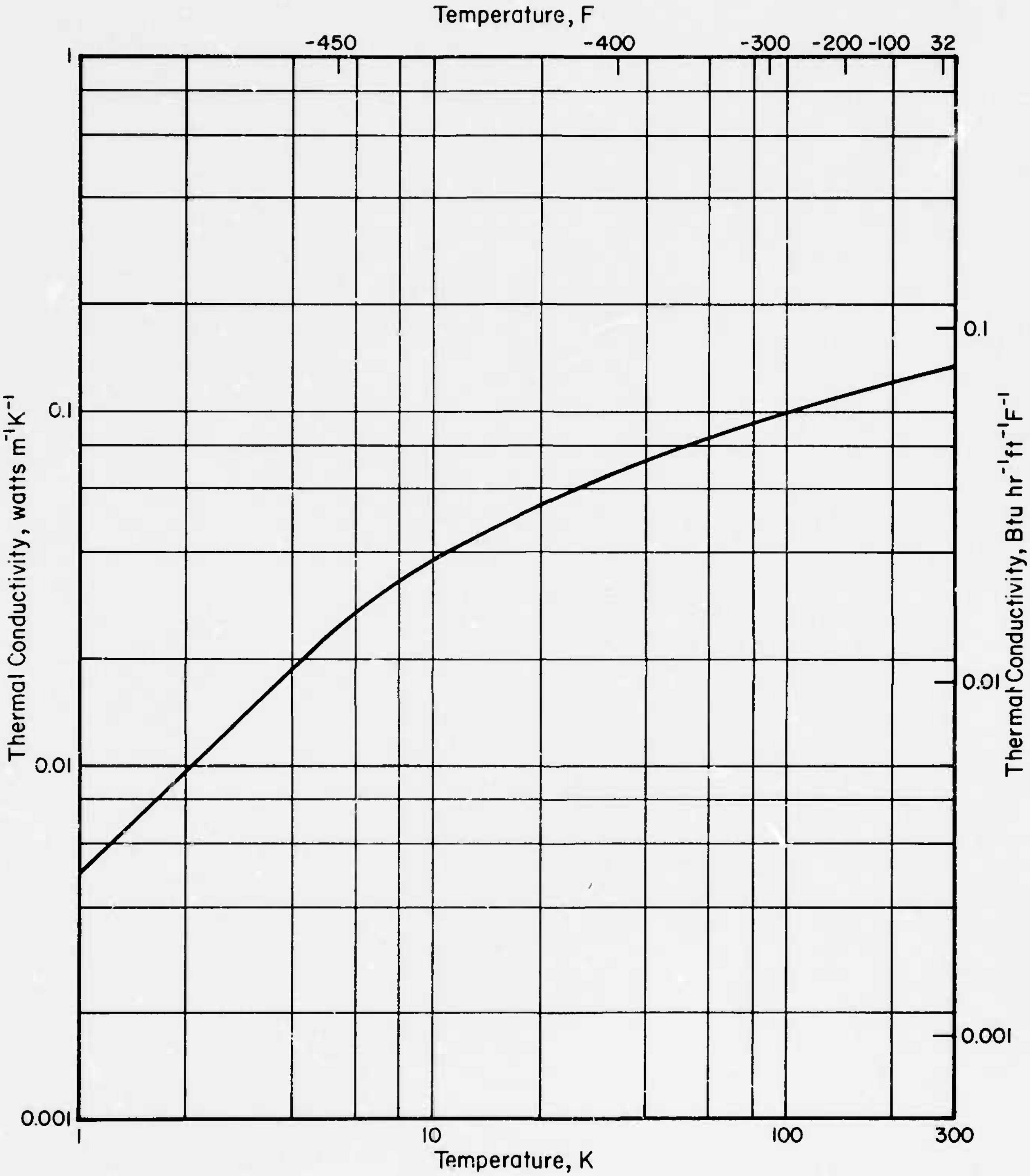

FIGURE 12.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYCHLOROTRIFLUORDETHYLENE (KEL-F)

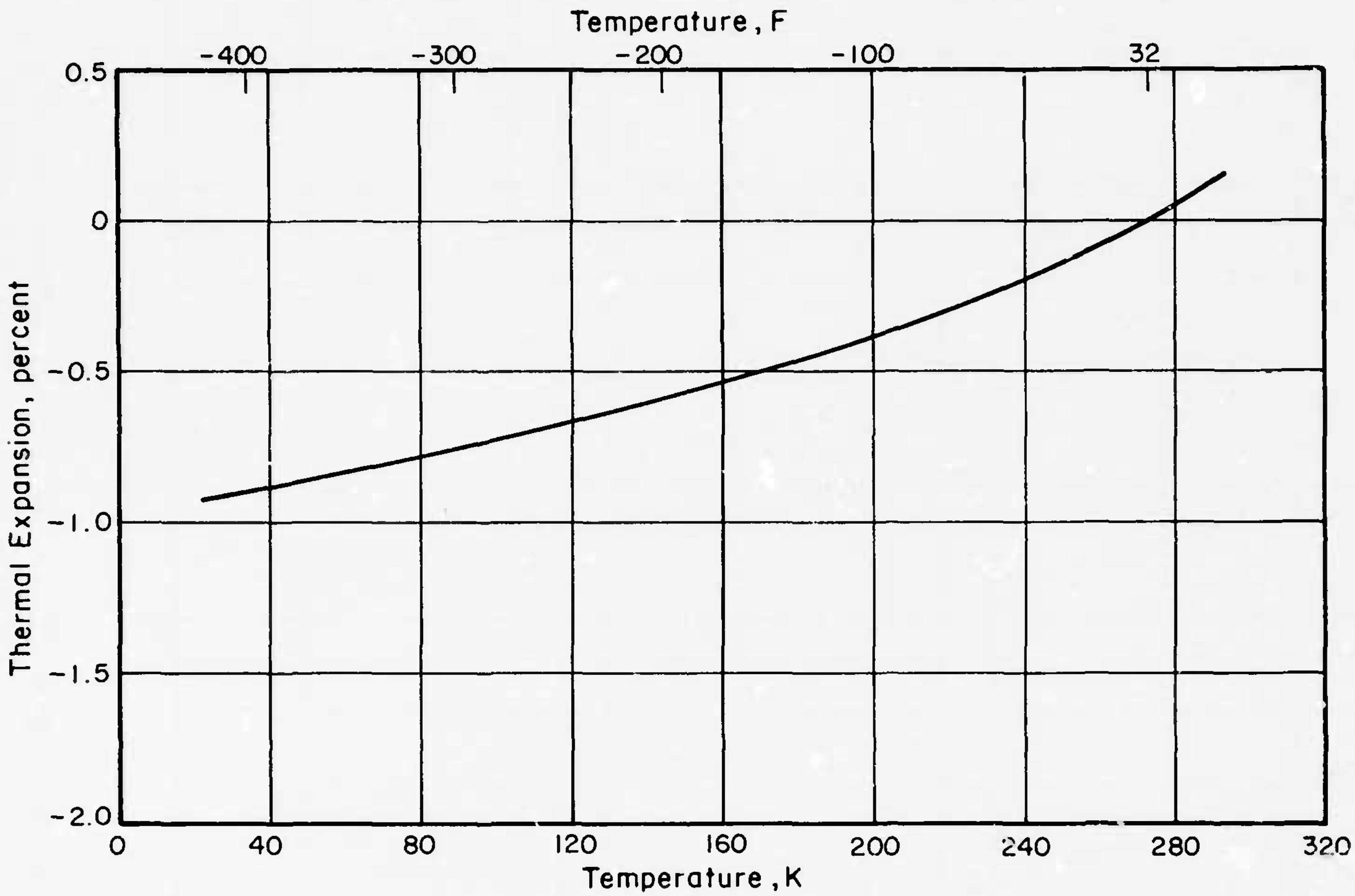

FIGURE 12.1.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR POLYCHLOROTRIFLUOROETHYLENE(KEL-F)

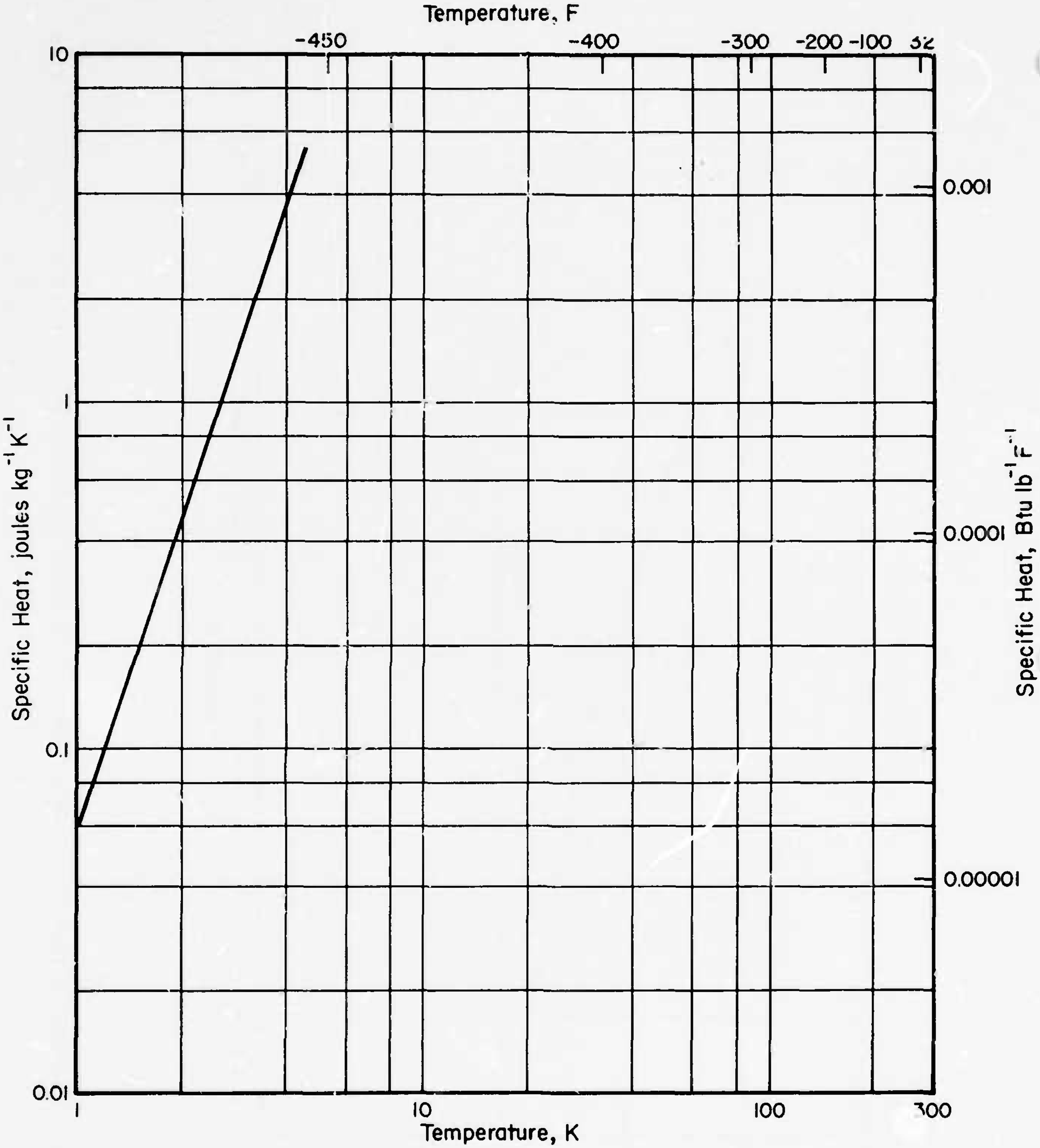

FIGURE 12.1.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYCHLOROTRIFLUOROETHYLENE (KEL-F)

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TABLE 12.1.3-TR1

Alloy Designation: Polytetrafluoroethylene (Teflon)

Specification:
Form:
Dimension:
Condition: Amorphous

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}											0.032	
Btu hr^{-1} ft^{-1} F^{-1}												(0.018)
No. of Spec.											1	
References: 96881												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent	0		-1.48		-1.57							
No. of Spec.	1		1		1							
References: 94202												
Specific Heat												
Joules kg^{-1} K^{-1}	940		380		200		75		20.5		2.2	
Btu lb^{-1} F^{-1}		(0.225)		(0.0908)		(0.0478)		(0.0179)		(0.00490)		(0.000526)
No. of Spec.	2		2		2		2		2		2	
References: 94196, 94203												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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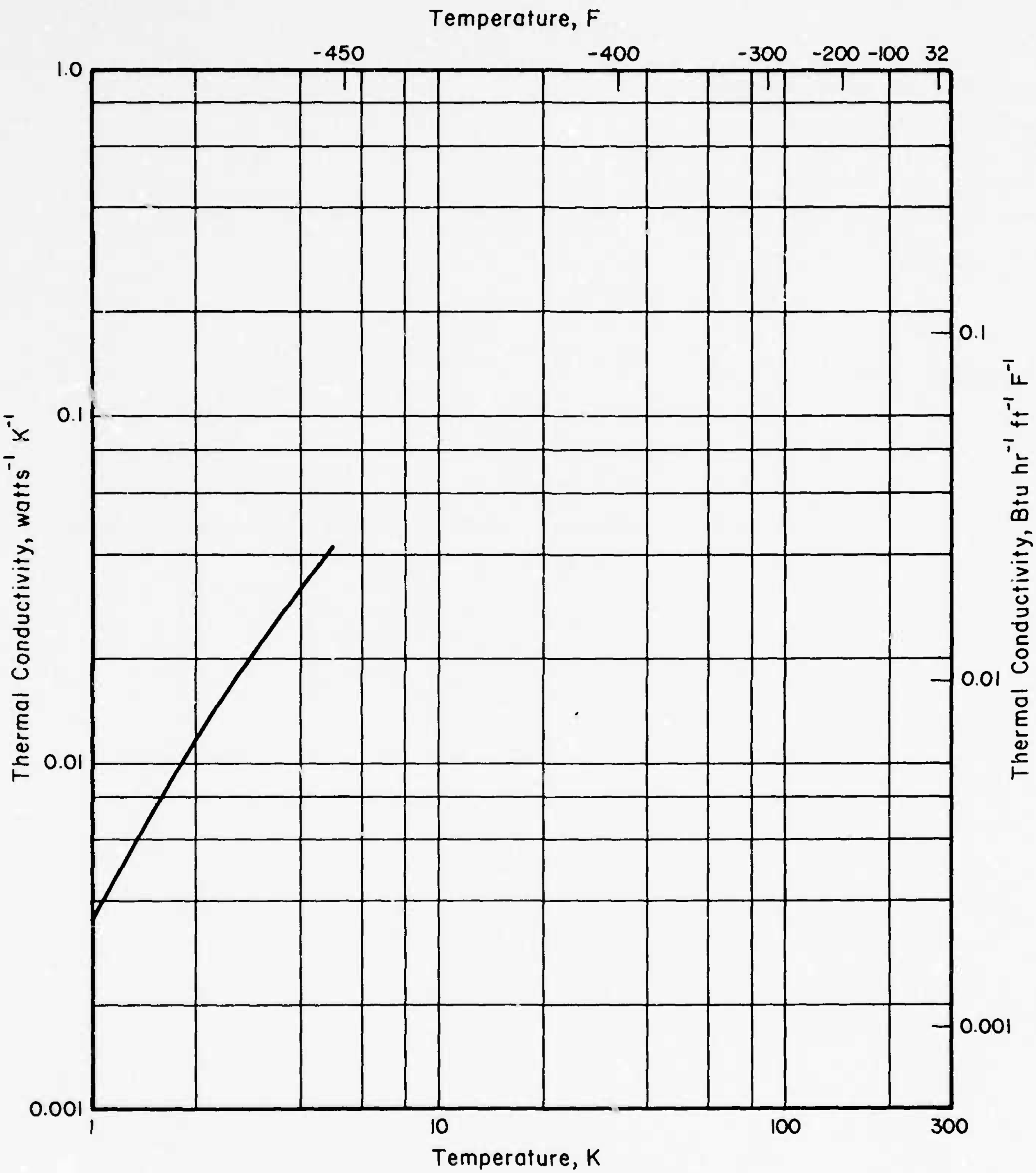

FIGURE 12.1.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYTETRAFLUOROETHYLENE (TEFLON)

TABLE 12.1.3-MA1

Polymer Designation: Polytetrafluoroethylene (Teflon)

Specification:

Form: Rod

Diameter, cm(in.): ~1 (?)

Condition: As received, with treatment in boiling aqua regia to remove surface impurities

Volume Susceptibility (k)* as a Function of Temperature and Field Strength

Temperature, K (F)	Low	Medium	Infinite
6.1 (-448)	-105.0×10^{-7}	-106.9×10^{-7}	-108.8×10^{-7}
16.8 (-429)	-107.6×10^{-7}	-109.2×10^{-7}	-110.4×10^{-7}
30.0 (-405)	-109.5×10^{-7}	-110.4×10^{-7}	-111.4×10^{-7}
48.8 (-372)	-109.9×10^{-7}	-110.9×10^{-7}	-111.9×10^{-7}
64.7 (-343)	-110.2×10^{-7}	-111.0×10^{-7}	-111.9×10^{-7}
81.7 (-312)	-109.3×10^{-7}	-109.9×10^{-7}	-110.5×10^{-7}
102.1 (-275)	-109.6×10^{-7}	-110.1×10^{-7}	-110.7×10^{-7}
152.5 (-185)	-109.9×10^{-7}	-110.4×10^{-7}	-110.8×10^{-7}
194.8 (-109)	-110.1×10^{-7}	-109.8×10^{-7}	-110.9×10^{-7}
255.2 (-0.3)	-110.1×10^{-7}	-110.3×10^{-7}	-110.5×10^{-7}
292.0 (66)	-110.0×10^{-7}	-110.1×10^{-7}	-110.3×10^{-7}

Note: μ_{mksa} $\sim 12.57 \times 10^{-7}$ for all values of k.

Reference: 96890

* in mksa units.

TABLE 12.2.1-TR1

Alloy Designation: **Polymethylmethacrylate (Plexiglas)**

Specification:
Form:
Dimension:
Condition: Amorphous

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}											0.052	
Btu hr^{-1} ft^{-1} F^{-1}												(0.030)
No. of Spec.											4	
References: 96872, 96880, 96889												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}	1280		550		275		79		22		2.4	
Btu lb^{-1} F^{-1}		(0.306)		(0.131)		(0.0657)		(0.0189)		(0.00526)		(0.000574)
No. of Spec.	2		2		2		2		2		1	
References: 94201, 94203												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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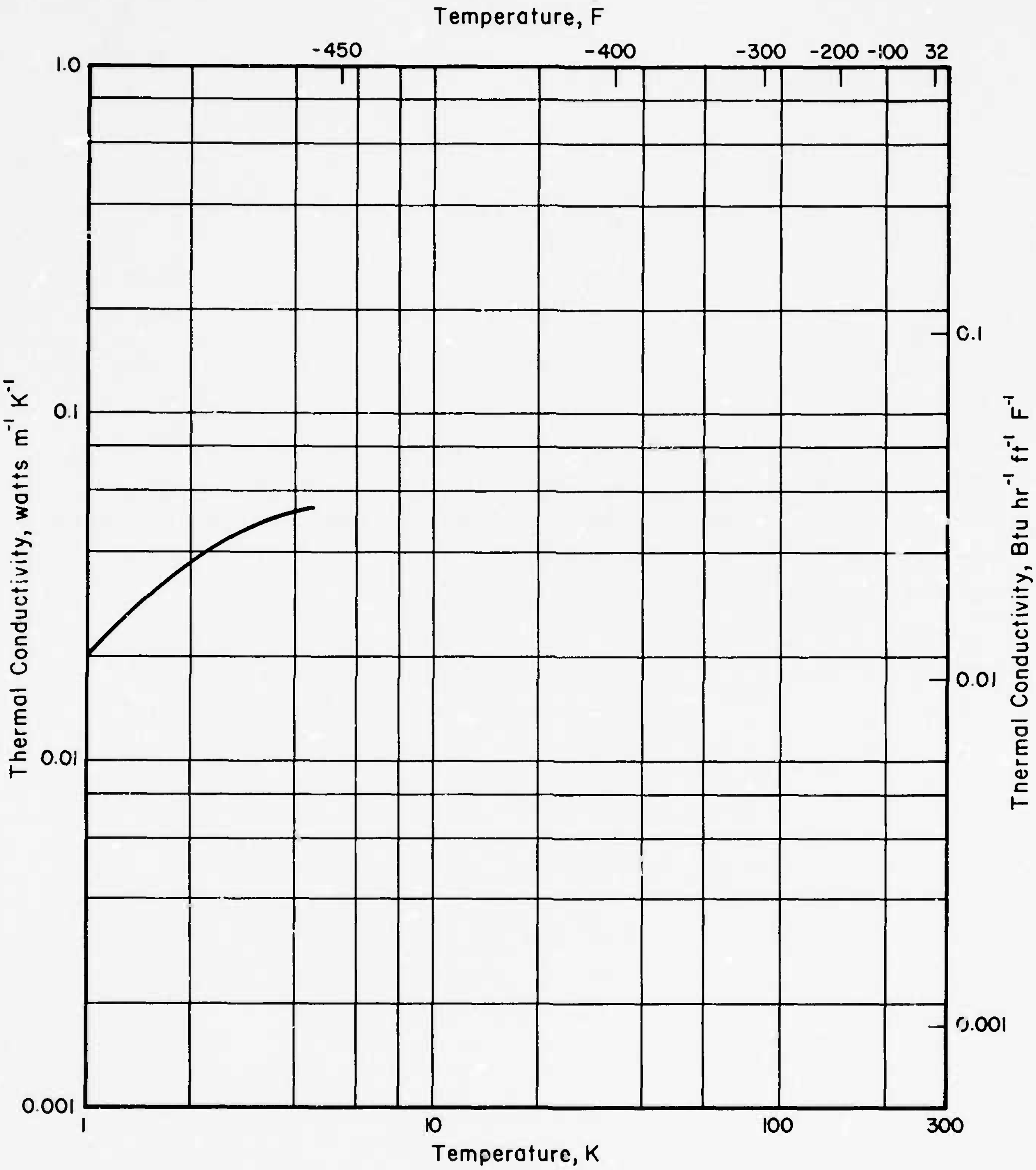

FIGURE 12.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYMETHYLMETHACRYLATE (AMORPHOUS)

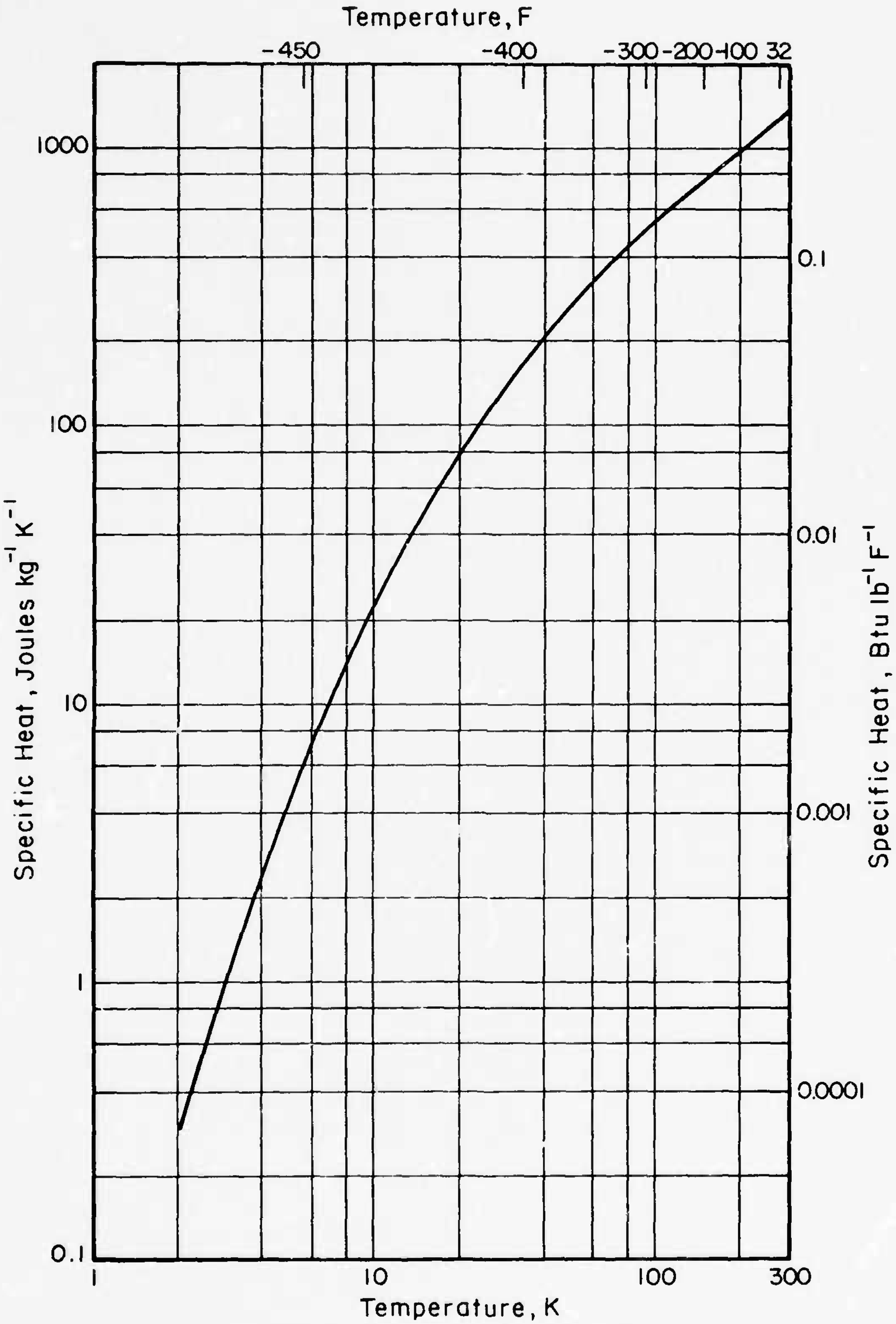

FIGURE 12.2.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYMETHYLMETHACRYLATE (PLEXIGLAS)

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TABLE 12.3.1-TR1

Alloy Designation: Polystyrene

Specification:
Form:
Dimension:
Condition: Amorphous

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity												
Watts m^{-1} K^{-1}											0.0266	
Btu hr^{-1} ft^{-1} F^{-1}												(0.0154)
No. of Spec.											3	
References: 96872, 96880, 96882												
Thermal Expansion (T_{273} to T)												
Longitudinal												
Percent	0.00		-1.00		-1.23		-1.31		-1.31		-1.32	
No. of Spec.	1		1		1		1		1		1	
References: 96883												
Specific Heat												
Joules kg^{-1} K^{-1}	1130		455		270		102		32		5.1	
Btu lb^{-1} F^{-1}		(0.270)		(0.109)		(0.0645)		(0.0244)		(0.00765)		(0.00122)
No. of Spec.	2		2		2		2		2		1	
References: 94200, 94203												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

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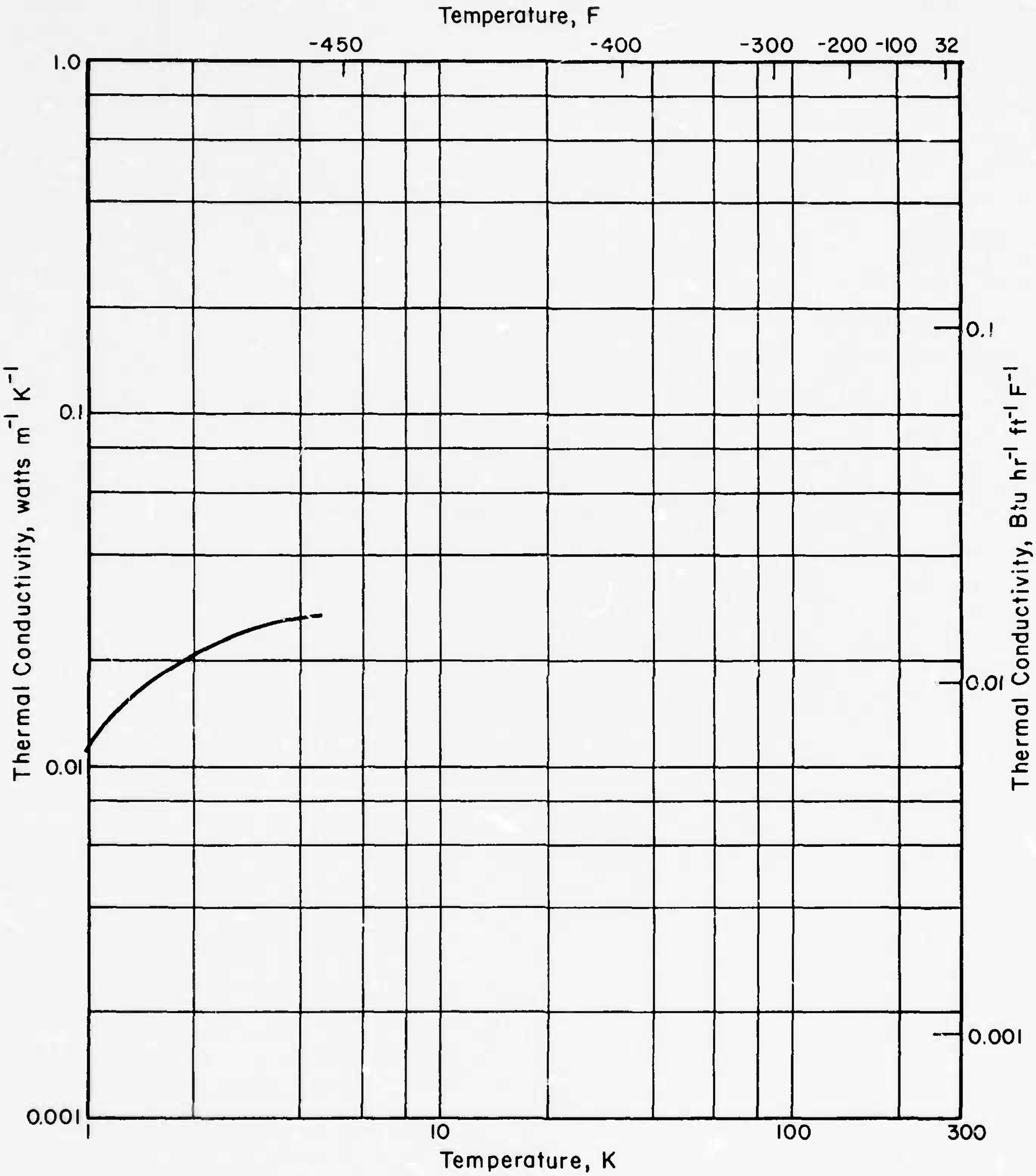

FIGURE 12.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYSTYRENE (AMORPHOUS)

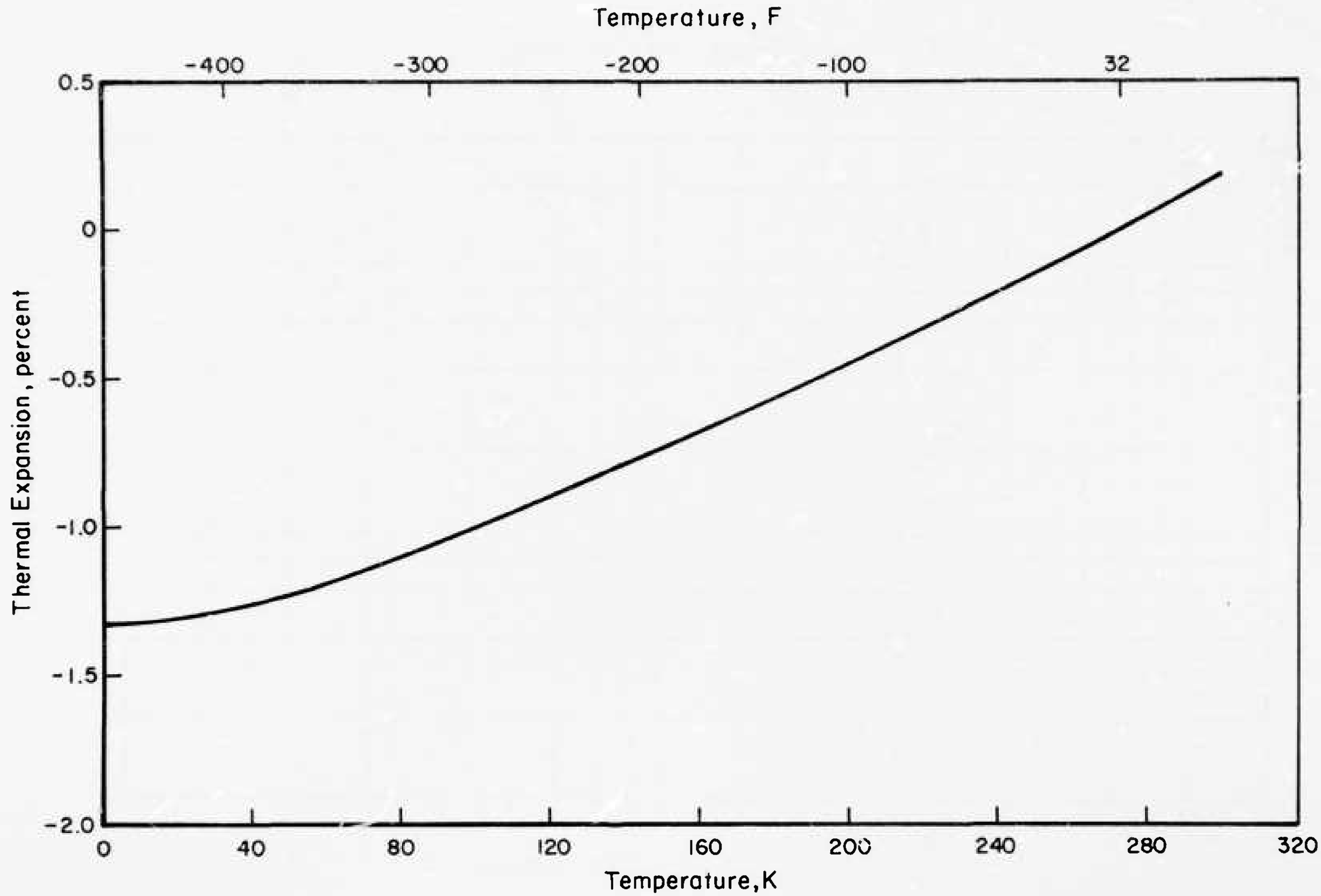

FIGURE 12.3.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR POLYSTYRENE (AMORPHOUS)

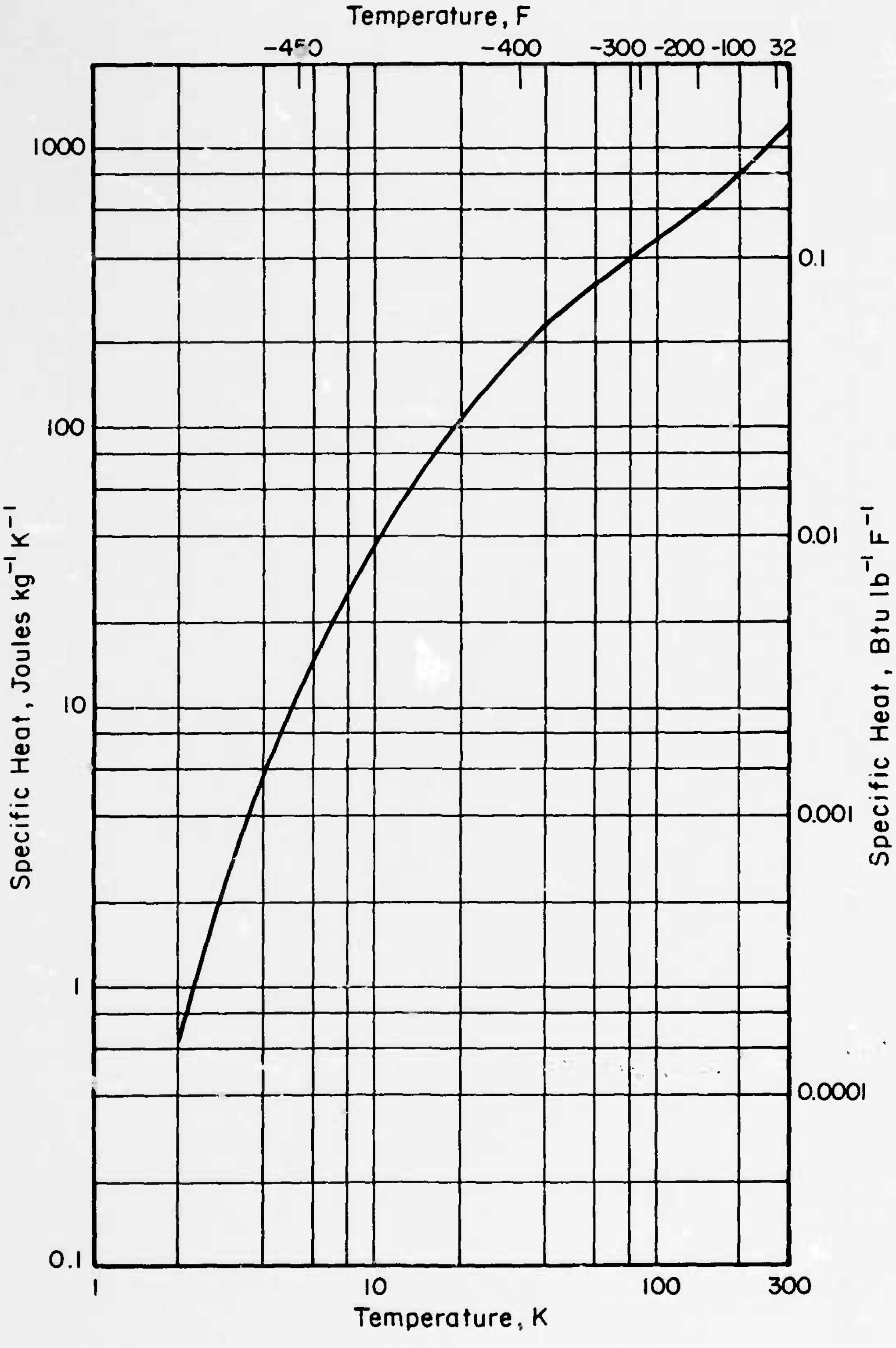

FIGURE 12.3.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYSTYRENE

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TABLE 12.4.1-TR1

Alloy Designation: POLYVINYLACETATE

Specification:
Form:
Dimension:
Condition: AMORPHOUS

Testing Temperature K (F)	273	(32)	100	(-280)	50	(-370)	20	(-423)	10	(-442)	4	(-452)
Thermal Conductivity (1)												
Watts m^{-1} K^{-1}											0.0179	
Btu hr^{-1} ft^{-1} F^{-1}												(0.010)
No. of Spec.											1	
References: 96872												
Thermal Expansion (T_{273} to T) Longitudinal												
Percent												
No. of Spec.												
References:												
Specific Heat												
Joules kg^{-1} K^{-1}												
Btu lb^{-1} F^{-1}												
No. of Spec.												
References:												
Electrical Resistivity												
Ohm m												
Ohm circular mil ft^{-1}												
No. of Spec.												
References:												

(1) Density = 1.20 g/cm^3
Molecular Weight=105,000

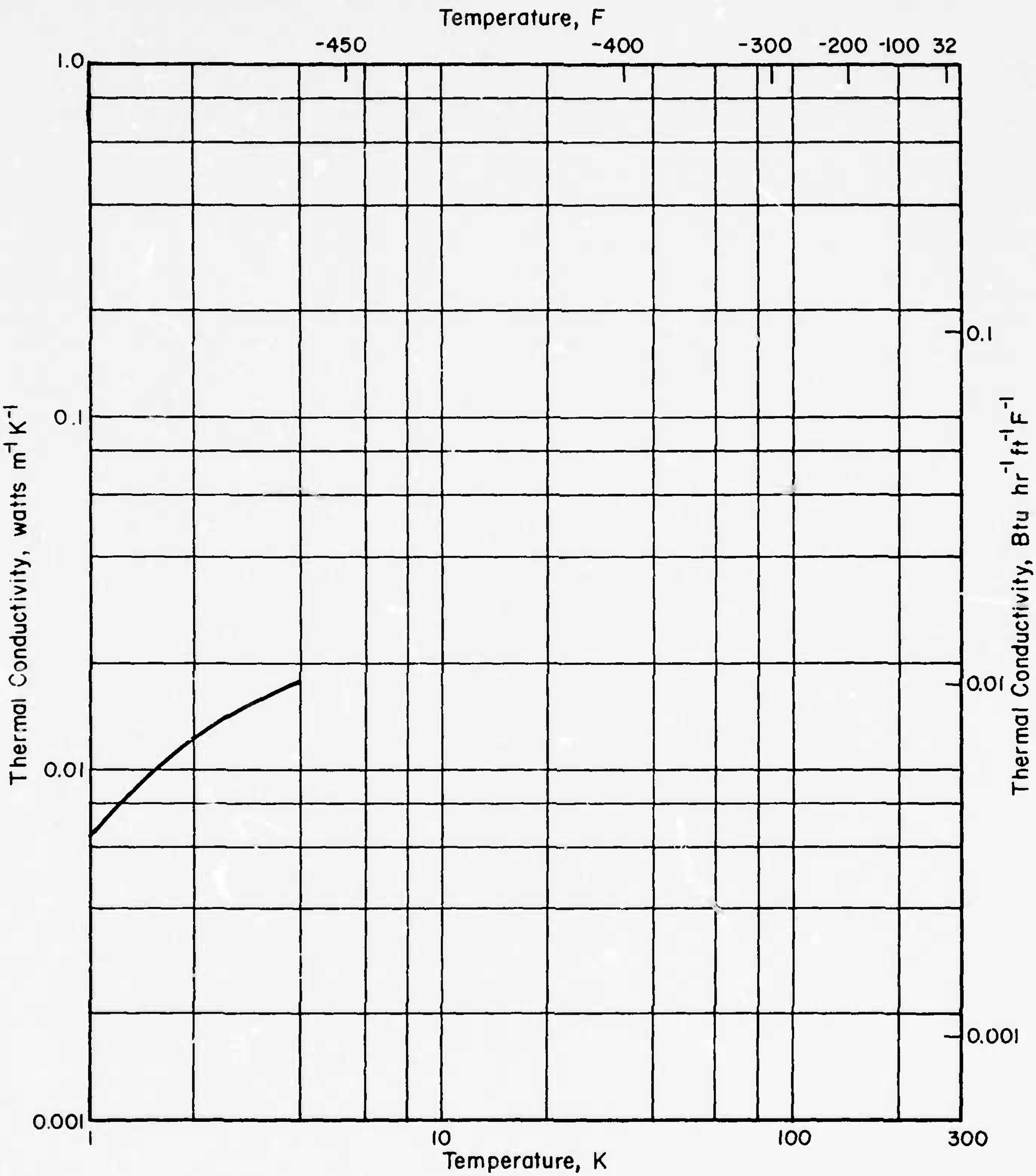

FIGURE 12.4.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYVINYLACETATE (AMORPHOUS)

REFERENCES

26638 Kemp, W.R.G., Klemens, P. G., and White, G. K., "Thermal and Electrical Conductivities of Iron, Nickel, Titanium, and Zirconium at Low Temperatures", Australian Journal of Physics, 9 (2), 180-188 (June 1956).

29830 McGee, R. L. and Campbell, J. E., "The Mechanical Properties of Certain Aircraft Structural Metals at Very Low Temperatures", Technical Report ASD-TR-58-386, Battelle Memorial Institute (November, 1958).

33262 Baughman, R. A., "Gas Atmosphere Effects on Materials", Final Report, R59FPD456, General Electric Company, WPAFB Contract AF 33(616)-5667 (June 15, 1959).

35611 Belton J. H., Godby, L. L., and Taft, B. L., "Materials for Use at Liquid Hydrogen Temperatures", Paper presented at the Sixty-Third Annual ASTM Meeting, Atlantic City, N. J., June 26-July 1, 1963.

36821 DeSisto, T. S., "The True-Stress True-Strain Properties of Titanium and Titanium Alloys as a Function of Temperature and Strain Rate", Technical Report WAL TR-405.2/4, Watertown Arsenal (March, 1960).

37146 Rice, L. P., Campbell, J. E., and Simmons, W. F., "The Evaluation of the Effects of Very Low Temperatures on the Properties of Aircraft and Missile Metals", WADD-TR-60-254, Battelle Memorial Institute, Contract AF 33(616)-6345 (June, 1960).

38611 Belton, J. H., Godby, L. L., and Taft, B. L., "Materials for Use at Liquid Hydrogen Temperatures", ASTM Special Technical Publication No. 287, 108-121 (June 30, 1960).

39077 Watson J. F. and Christian, J. L., "Mechanical Properties of High-Strength 301 Stainless Steel Sheet at 70°, -320°, and -423°F in the Base Metal and Welded Joint Configuration", ASTM Special Technical Publication No. 287, 136-149 (June 30, 1960).

39134 Kaufman, J. G. and Johnson, E. W., "New Data on Aluminum Alloys for Cryogenic Applications", Proceedings of the 1960 Cryogenic Engineering Conference, 637-649 (1961).

39414 Kropp, C. J. and Foor, E. R., "Mechanical Properties of Heat Treated A-286 Alloy at Various Testing Temperatures, Status Report No. 3", Technical Report MRG-157, Convair-Astronautics/General Dynamics (June 8, 1960).

39429 Watson J. F. and Christian, J. L., "The Effect of Cryogenic Temperatures on the Mechanical Properties of High Strength Sheet Alloys (Cold Worked Austenitic Stainless Steels)", Technical Report ERR-AN-003, Convair-Astronautics/General Dynamics (May 16, 1960).

39871 Guntner, C. J. and Reed, R. P., "Mechnical Properties of Four Austenitic Stainless Steels at Temperatures Between 300° and 20°K", Proceedings of the 1960 Cryogenic Engineering Conference, 565-576 (1961).

40004 DeSisto, T. S. and Carr, L. C., "Low Temperature Mechanical Properties of 300 Series Stainless Steel and Titanium", Proceedings of the 1960 Cryogenic Engineering Conference, 577-586 (1961).

40128 Christian, J. L., "Mechanical Properties of Titanium and Titanium Alloys at Cryogenic Temperatures", Technical Report MRG-189, Convair-Astronautics/General Dynamics (October 14, 1960).

40911 Johnson, V. J., "A Compendium of the Properties of Materials at Low Temperatures (Phase I). Part II. Properties of Solids", WADD-TR-60-56, Part II, NBS, WPAFB Contract AF 33(616)-58-4 (October, 1960).

40953 Hanson, M. P., "Smooth and Sharp-Notch Tensile Properties of Cold-Reduced AISI 301 and 304L Stainless Steel Sheet at 75°, -320°, and -423°F", NASA TN D-592, Lewis Research Center (February, 1961).

42002 Markovich, R. and Schwartzberg, F., "Testing Techniques and Evaluation of Materials For Use at Liquid Hydrogen Temperatures", Technical Report R-61-4, The Martin Company (February, 1961).

42219 Corruccini, R. J. and Gniewek, J. J., "Specific Heats and Enthalpies of Technical Solids at Low Temperatures", NBS Monograph 21 (October 3, 1960).

41531 Anon., "Final Results from Operation Cryogenics", International Nickel Company, Inc. (1961).

44291 Chafey, J. E., "Compilation of Materials Research Data", Technical Report AE-62-0138-2, General Dynamics, Contract AF 33(616)-7984 (September, 1961).

45001 Favor, R. J., and Gideon, D. N., "Investigation of Fatigue Behavior of Certain Alloys in the Temperature Range: Room Temperature to 423 F", ASD-TR-61-132, Battelle Memorial Institute, Contract AF 33(616)-6888 (June 1961).

45136 Christian, J. L., "Determination of the Effect of Oxygen Content on the Mechanical Properties of Titanium — 5Al-2.5Sn Alloy at Room and Cryogenic Temperatures", Technical Report MRG-266, General Dynamics (October 20, 1961).

45464 DeSisto, T. S. and Carr, F. L., "Low Temperature Mechanical Properties of 300 Series Stainless Steels and Titanium", Technical Report WAL TR-323.4/1, Watertown Arsenal (December, 1961).

46356 Hurlich, A., "Materials Requirements for Cryogenic Temperature Applications", Paper presented at the ASM 1962 Golden Gate Metals Conference (February 15-17, 1962).

47125 Hanson, M. P. and Richards, H. T., "Smooth and Sharp-Notch Property Variations for Several Heats of Ti-6Al-4V Sheet at Room and Cryogenic Temperatures", NASA Technical Note D-1282 (May, 1962).

47311 Hickey, C. F., Jr., "Mechanical Properties of Titanium and Aluminum Alloys at Cryogenic Temperatures", Technical Report WAL-TR-340.2/1, Watertown Arsenal (March, 1962).

47334 Hickey, C. F., Jr., "Mechanical Properties of Titanium and Aluminum Alloys at Cryogenic Temperatures", Preprint of paper presented at the Sixty-Fifth Annual ASTM Meeting (June 25-29, 1962).

47735 King, E. J., "Cryogenic Properties of 2014-T6 and A-286. Phase II", Technical Report BLR-61-35-M, Bell Aerosystems Company, Contract AF 33(657)-8555 (June, 1962).

48128 Guntner, C. J. and Reed, R. P., "The Effect of Experimental Variables Including the Martensitic Transformation on the Low-Temperature Mechanical Properties of Austenitic Stainless Steels", Transactions of the ASM, 55, 399-419 (September, 1962).

48134 Arp, V., Wilson, J. H., Winrich, L., and Sikora, P., "Thermal Expansion of Some Engineering Materials From 20° to 293°K", Cryogenics, 2 (4), 1-6 (June, 1962).

48561 Rice, L. P., Campbell, J. E., and Simmons, W. F., "The Tensile Property Evaluation of One 5000-Series Aluminum Alloys at the Temperature of Liquid Helium", Proceedings of the 1962 Cryogenic Engineering Conference, 671-677 (1963).

48570 Ziegler, W. T., Mullins, J. C., and Hwa, S.C.P., "Specific Heat and Thermal Conductivity of Four Commercial Titanium Alloys From 20° to 300°K", Proceedings of the 1962 Cryogenic Engineering Conference, 268-277 (1963).

48571 Rhodes, B. L., Moeller, C. E., Hopkins, V., and Marx, T. I., "Thermal Expansion of Several Technical Metals From -255° to 300°C", Proceedings of the 1962 Cryogenic Engineering Conference, 278-286 (1963).

48652 Christian, J. L., "Physical and Mechanical Properties of Pressure Vessel Materials for Application in a Cryogenic Environment", ASD-TDR-62-258, General Dynamics, Contract AF 33(616)-7719 (March, 1962).

48787 Kaufman, J. G., and Nelson, F. G., "Cryogenic Temperatures up Fatigue Strengths of Al-Mg Alloys", Space/Aeronautics, 38 (1), 91-93 + 96 (July 1962).

49048 Gideon, D. N., Favor, R. J., Koppenhafer, A., Grover, H. J., and McClure, M., "Investigation of Notch Fatigue Behavior of Certain Alloys in the Temperature Range of Room Temperature to -423°F", ASD-TDR-62-351, Battelle Memorial Institute, WPAFB Contract AF 33(616)-6888 (August, 1962).

49088 Watson, J. F., Christian, J. L., and Hertz, J., "Selection of Materials for Cryogenic Applications in Missiles and Aerospace Vehicles", Technical Report GDA-MRG-132-1, General Dynamics (February, 1960).

49225 Anon., "Titanium for Liquid Hydrogen Applications. Investigation of the Influence of Chemistry on Low Temperature Behavior of Titanium Alloys", Data Sheets EFE, Titanium Metals Corporation of America (May, 1962).

49349 Hilsen R. R., Yen, C. S., and Whiteson, B. V., "Low Cycle Fatigue of Ti-6Al-4V at -423 F", Paper No. 48 presented at the American Society for Testing and Materials Meeting, Los Angeles, California (October 1-5, 1962).

49971 Christian, J. L., "The Effects of Cold Rolling on the Mechanical Properties of Type 310 Stainless Steel at Room and Cryogenic Temperatures", Technical Report AR-592-1-329, General Dynamics (July 24, 1962).

50498 Christian, J. L., Hurlich, A., Chafey, J. E., and Watson, J. F., "Mechanical Properties of Titanium-5Al-2.5Sn Alloy at Room and Cryogenic Temperatures", Technical Report AR-592-1-373, Astronautics/General Dynamics (1963).

51070 Christian, J. L., "Mechanical Properties of High-Strength Sheet Materials at Cryogenic Temperatures", Technical Report ERR AN 255, Astronautics/General Dynamics (November 28, 1962).

51156 Schwartzberg, F. R. and Keys, R. D., "Mechanical Properties of 2000 Series Aluminum Alloys at Cryogenic Temperatures", Technical Report R-61-32, The Martin Company (October, 1961).

51527 Christian, J. L. and Hurlich, A., "Physical and Mechanical Properties of Pressure Vessel Materials for Application in a Cryogenic Environment. Part II", ASD-TDR-62-258, Part II,Astronautics/General Dynamics, WPAFB Contract AF 33(616)-7719 (April, 1963).

52856 DeSisto, T. S., "Low Temperature Mechanical Properties of Base and Weld Deposits of Selected Austenitic Stainless Steels", Technical Report AMRA-TR-63-08, Watertown Arsenal (July, 1963).

52862 King, E. J., "Investigation of Aluminum Alloy 6061-T4, T6 Welded and Unwelded", Technical Report BLR-61-40-M, Bell Aerosystems Company, Contract AF 33(657)-8555 (December, 1961).

53308 Schwartzberg, F. R., Keys, R. D., Brown, M. J., and Reightler, C. L., "Determination of Low-Temperature Fatigue Properties of Aluminum and Titanium Alloys", NASA CR-63-29, The Martin Company, Contract NAS 8-2631 (July, 1963).

53354 Christian, J. L. and Kerr, J. R., "Selection of Optimum Materials for Use in Liquid-Hydrogen-Fueled Aerospace Vehicles", ASD-TDR-63-798, Astronautics/General Dynamics, WPAFB Contract 33(657)-9445 (October, 1963).

53548 Morgan, W. R., "Low Temperature Mechanical Properties of A-286 Alloy and Its Weldments", Technical Report IN-P&VE-M-62-4, NASA George C. Marshall Space Flight Center (1962).

53885 Anderson, W. A., Kaufman, J. G., and Kane, J. E., "Notch Sensitivity of Aluminum-Zinc-Magnesium Alloys at Cryogenic Temperatures", Proceedings of the 1963 Cryogenic Engineering Conference, 104-111 (1964).

54986 Warren, K. A. and Reed, R. P., "Tensile and Impact Properties of Selected Materials From 20° to 300°K", National Bureau of Standards Monograph 63 (June 28, 1963).

55021 Wroth, R. S., "Effect of Filler Metal Chemistry on the Mechanical Properties of Weldments in 2014-T6 Aluminum", Technical Report SM-43090, Douglas Aircraft Company (1963).

55111 Brisbane, A. W., "The Influence of Loading Rate and Stress Concentration Factors on Notch Properties of Three Sheet Alloys at Room Temperature, -78°C, and -196°C", Proceedings of the 1962 Cryogenic Engineering Conference, 641-653 (1963).

55916 Tiffany, C. F., and Lorenz, P. M., "An Investigation of Low-Cycle Fatigue Failures Using Applied Fracture Mechanics", ML-TDR-64-53, The Boeing Company WPAFB Contract AF 33(657)-10251 (May 1964).

56105 DeSisto, T. S. and Carr, F. L., "The Influence of Subzero Rolling on the Tensile Properties of Commercially Pure Titanium", Technical Report AMRA TR-64-47, Watertown Arsenal (December, 1964).

56261 Christian, J. L., Yang, C. T., and Witzell, W. E., "Physical and Mechanical Properties of Pressure Vessel Material for Application in a Cryogenic Environment", Summary Report GD/A 63-0818-3, Astronautics/General Dynamics, Contract AF 33(657)-11289, Phase II (May 15, 1964).

56510 Anon., "Cryogenic Tensile Properties of Ti-5Al-2.5Sn", Technical Report M-2135, Aerojet-General Corporation (May 14, 1963).

56750 Kiefer, T. F., Keys, D. R., and Schwartzberg, F. R., "Charpy Impact Testing at 20°K", Proceedings of the 1964 Cryogenic Engineering Conference, 56-62 (1965).

56753 Kiefer, T. F. and Keys, R. D., "Fatigue Behavior of Aluminum and Titanium Sheet Materials Down to -423°F", Proceedings of the 1964 Cryogenic Engineering Conference, 1-13 (1965).

56754 Weleff, W., Emmons, W. F., and McQueen, H. S., "Shear Strength of Several Alloys at Liquid-Hydrogen Temperatures", Proceedings of the 1964 Cryogenic Engineering Conference, 50-55 (1965).

56755 Weleff, W., McQueen, H. S., and Emmons, W. F., "Cryogenic Tensile Properties of Selected Aerospace Materials", Proceedings of the 1964 Cryogenic Engineering Conference, 14-25 (1965).

57635 Orange, T. W., "Tensile Coupon Tests of Cryoformed AISI 301 Stainless-Steel Pressure Vessels at Cryogenic Temperatures", NASA Technical Note NASA TN D-2202 (October, 1964).

58024 Schwartzberg, F. R., Kiefer, T. F., and Keys, R. D., "Determination of Low-Temperature Fatigue Properties of Structural Metal Alloys", Final Report, The Martin Company, Contract NAS 8-2631 (October, 1964).

58060 Martin, H. L., "Effects of Low Temperatures on Structural Metals", Technical Report NASA SP-5012 (December, 1964).

58761 Eichenberger, T. W., "Mechanical Property and Fracture Toughness Evaluation of 2219-T6E46 for Cryogenic Applications", Final Report D2-81287, Boeing Company, Contract AF 33(615)-1624 (July 16, 1964).

59159 Shannon, J. L., Jr. and Brown, W. F. Jr., "Effects of Several Alloy Production and Fabrication Variables on the Sharp Notch Properties of 5Al-2.5Sn-Ti Sheet at Liquid Hydrogen Temperatures", Paper presented at the Annual ASTM Meeting, Atlantic City, N. J. (June 23, 1963).

59345 Girton, L. D., "Evaluation of Sheet Alloy 718 for Formed and Welded Missile Parts", Technical Report GD/A-ERR-AN-656, General Dynamics/Astronautics (December 1964).

59767 Gruner, J. D., "Additional Information Pertaining to the Effects of Chemical Milling on the Mechanical Properties of Cold Rolled Stainless Steel", Technical Report AR 592-1-521, Astronautics/General Dynamics (April 16, 1964).

59901 Gruner, J. D., "The Effects of Chemical Milling and Chemically Milled Steps on the Mechanical Properties of Type 301 EH and Type 310 EH Stainless Steels at Room and Liquid Hydrogen Temperatures", Technical Report AR-592-1-473, Convair/General Dynamics (July 3, 1963).

60578 Christian, J. L., Yang, C. T., and Witzell, W. E., "Physical and Mechanical Properties of Pressure Vessel Materials for Application in a Cryogenic Environment. Part III", Technical Report ASD-TDR-62-258-Part 3, General Dynamics, Contract AF-33(657)-11289 (December 1964).

61688 McClaren, S. W. and Foreman, C. R., "Cryogenic Design Data for Materials Subjected to Uniaxial and Multiaxial Stress Field", Technical Report AFML-TR-65-140, Ling-Temco-Vought, Incorporated, Contract AF 33(615)-1329 (May, 1965).

61918 Pierce, W. S., "Strength Comparison of Flawed Single-Layer and Multilayer AISI 301 Stainless-Steel Pressure Vessels at Cryogenic Temperatures", NASA Technical Note NASA TN D-2949, NASA Lewis Research Center (October 1965).

61996 Kiefer, T. F., Keys, R. D., and Schwartzberg, F. R., "Determination of Low-Temperature Fatigue Properties of Structural Metal Alloys", Final Report, The Martin Company, Contract NAS 8-11300 (October, 1965).

62292 Lorenz, P. M., "Fracture Toughness and Subcritical Flaw Growth Characteristics of Saturn SI-C Tankage Materials", Technical Report D2-22802, Boeing Company, Contract NAS 8-5608 (April 6, 1964).

63362 Nelson, F. G., Kaufman, J. G., and Holt, M., "Fracture Characteristics of Welds in Aluminum Alloys", Metals Engineering Quarterly, 6 (1), 48-55 (February 1966).

63649 Betts, R. D., "Weld Efficiencies for Inconel 718 TIG Welds. Weld Efficiencies of Inconel 718 Gas Tungsten Arc Welds in the -423° to 1500°F Temperature Range", Final Report MPR-5-175-363, North American Aviation, Incorporated (July 27, 1965).

64335 Anon., "Armco 21-6-9 Stainless Steel", Product Data Bulletin S-10A, Armco Steel Corporation (1964).

64353 Weiss, V., and Roy A., "Further Material Evaluation for Supersonic Transport Aircraft", Final Report, S.U.R.I. Report MET. E. 873-6312-F, Syracuse University Research Institute, Contract NASr-43 (December 1963).

64373 Schwanbeck, C. A., "Effect of Nuclear Radiation on Materials at Cryogenic Temperatures", Final Report, NASA CR-54881, Lockheed-Georgia Company, Contracts NAS 3-7987 and NASw-114 (January, 1965).

64658 Denaburg, C. R., "Low Temperature Mechanical Properties of Aluminum Alloy 2219-T87, 0.040-Inch Thick Sheet Through 5.000-Inch Thick Plate", NASA TM X-53332 (September 14, 1965).

64969 Carman, C. M., Forney, J. W., and Katlin, J. M., "Plane Strain Fracture Toughness and Mechanical Properties of 5Al-2.5Sn ELI Titanium at Room and Cryogenic Temperatures", Final Report, NASA CR-54296, Frankford Arsenal, NASA Purchase Order C6860A (April, 1966).

65177 Christian, J. L., "Mechanical Properties of Several Nickel-Base Alloys at Room and Cryogenic Temperatures", Proceedings of the 1966 Cryogenic Engineering Conference, 520-530 (1967).

65182 Weleff, W., "Radiation Effects on Shear Strength of Several Alloys at Liquid Hydrogen Environment", Proceedings of the 1966 Cryogenic Engineering Conference, 544-556 (1967).

65184 Eiselstein, H. L., "An Age-Hardenable, Low-Expansion Alloy for Cryogenic Service", Proceedings of the 1966 Cryogenic Engineering Conference, 508-519 (1967).

66001 Witherell, C. E., "Welding Nickel-Iron Alloys of the Invar Type", Welding Journal, Welding Research Supplement, 43, 161s-169s (April 1964).

66080 Stinnett, W. D., "Cryogenic Tensile Properties of Selected Materials", Research Report 2712, NASA CR-71751, Aerojet-General Corporation, AEC-NASA Contract SNP-1 (January 1, 1946).

66103 Ferguson, C. W., "Hypervelocity Impact Effects on Liquid Hydrogen Tanks", Final Report, NASA CR-54852, Douglas Missile & Space Systems, Contract NAS-3-4193 (March 31, 1966).

66167 Carman, C. M., Forney, J. W., and Katlin, J. M., "Plane Strain Fracture Toughness of 2219-T87 Aluminum Alloy at Room And Cryogenic Temperatures", Technical Report R-1821, NASA CR-54297, Frankford Arsenal, NASA Purchase Order C6860A (August, 1966).

66218 Tiffany, C. F., Lorenz, P. M., and Hall, L. R., "Investigation of Plane-Strain Flaw Growth in Thick-Walled Tanks", Final Report, NASA CR-54837, Boeing Company, Contract NAS 3-4194 (February, 1966).

66577 Tilley, E. B., "Evaluation of Inconel 718 Alloy", Technical Report RDR 1181-2, International Harvester Company (June 1, 1965).

66886 Kropp, C. J., "The Development of a Superior Titanium-Base Alloy for Cryogenic Applications", Technical Report AFML-TR-65-308, Volume II, Convair/General Dynamics, Contract AF 33(615)-1361 (September, 1966).

67747 Christian, J. L., Gruner, J. D., and Girton, L. D., "The Effects of Cold Rolling on the Mechanical Properties of Type 310 Stainless Steel at Room and Cryogenic Temperatures", Technical Report AR-592-1-365, NASA CR-54614, Astronautics/General Dynamics (November 27, 1962).

67769 Robinson, I. B., and Baysinger, F. R., "Welding Aluminum Alloy 7039", Welding Journal Research Supplement, 45, 433s-444s (October 1966).

68968 Sullivan, T. L., "Uniaxial and Biaxial Fracture Toughness of Extra-Low-Interstitial 5Al-2.5Sn Titanium Alloy Sheet at 20°K", NASA Technical Note NASA TN D-4016 (June, 1967).

69021 Inouye, F. T., Hunt, V., Janser, G. R., and Frick, V., "Application of Alloy 718 in M-1 Engine Components", Technical Report NASA CR-788, Aerojet-General Corporation, Contract NAS 3-2555 (June, 1967).

69310 Beck, E. J. and Mallon J. A., "Common Bulkhead Joint Development and Evaluation", Final Report , NASA CR-66-47, The Martin Company, Contract NAS 8-20125 (July, 1966).

69332 Horton, J. C., Smith, C. F., and Ruff, R. C., "Low Temperature Thermal Expansion of Structural Metals", Technical Memorandum NASA TM X-53436 (April 18, 1966).

69759 Eitman, D. A. and Rawe, R. A., "Plane Stress Cyclic Flaw Growth of 2219-T87 Aluminum and 5Al-2.5Sn ELI Titanium Alloys at Room and Cryogenic Temperatures", Final Report, NASA CR-54956, Douglas Aircraft Company, Contract NAS 3-4192 (September 1, 1962).

69800 McClaren, S. W., Foreman, C. R., and Grabinski, J. F., "Biaxial Strength Characteristics of Selected Alloys in a Cryogenic Environment", Final Report 2-53420/6R-2279, NASA CR-65412, LTV Aerospace Corporation, Contract NAS 9-3873 (May 6, 1966).

70525 Janser, G. R., "Summary of Materials Technology of M-1 Engine", Technical Report AGC 8800-64, NASA CR-54961, Aerojet-General Corporation, Contract NAS 3-2555 (July 22, 1966).

70906 Nachtigall, A. J., Klima, S. J., and Freche, J. C., "Fatigue of Liquid Rocket Engine Metals at Cryogenic Temperatures to −425°F (4°K)", NASA Technical Note NASA TN D-4274 (December, 1967).

71237 Malin, C. O., "Low Temperature Properties of Selected Cast and Wrought Aerospace Alloys", Materials and Processes Technical Report MPTR 6-176A-8, Rocketdyne/North American (1968).

72563 Kaufman, J. G., Bagardus, K. O., and Wanderer, E. T., "Tensile Properties and Notch Toughness of Aluminum Alloys at −452°F in Liquid Helium", Proceedings of the 1967 Cryogenic Engineering Conference, 294-308 (1968).

73890 Smith, G. W., "Centaur Biaxial Fatigue Tests— Model 55", Technical Report AE62-0866, Astronautics/General Dynamics, Contract AF 18(600)-1775 (October 15, 1962).

74405 Clark, A. F., "Low Temperature Thermal Expansion of Some Metallic Alloys", Cryogenics, 8 (5), 282-289 (October, 1968).

75531 Hall, L. R., "Plane-Strain Cyclic Flaw Growth in 2014-T62 Aluminum and 6Al-4V (ELI) Titanium", NASA CR-72396, Boeing Company, Contract NAS 3-7993 (November 1968).

76411 Wessel, E. T., Clark, W. G., and Wilson, W. K., "Engineering Methods for the Design and Selection of Materials Against Fracture", Final Technical Report, Westinghouse Research Laboratories (June 24, 1966).

76455 Pyle, R., Schillinger, D. E., and Carman, C. M., "Plane Strain Fracture Toughness and Mechanical Properties of 2219-T87 Aluminum and 5Al-2.5Sn ELI Titanium Alloy Weldments and One-Inch Thick 5Al-2.5Sn ELI Titanium Alloy Plate", FA Report R-1897, NASA CR-72154, Frankford Arsenal (September 1968).

76974 Susukida, H., Ando, T., and Tsuji, I., "Characteristics of 9% Nickel Steel for Low Temperature Service", Technical Report No. MTB010053, Mitsubishi Heavy Industries Ltd. (October 1967).

77044 Hust, J. G. and Powell, R. L., "Thermal Conductivity of Aerospace Alloys at Cryogenic Temperatures", Proceedings of the 8th Conference on Thermal Conductivity, Purdue University (October 7-10, 1968).

77930 Nachtigall, A. J., "Comparison of Tensile Properties of 304L and 310S Stainless Steels in Liquid Helium", NASA Technical Memorandum NASA TM X-52703 (October 30, 1969).

77998 Shogan, R. P., "Tensile Properties of Irradiated Ti-5%Al-2.5%Sn ELI at Cryogenic Temperatures", Technical Report WANL-TME-1860, Westinghouse Electric Company (November 1968).

78611 Pettit, D. E., Feddersen, C. E., and Mindlin, H., "Flaw Growth Behavior of Inconel 718 at Room and Cryogenic Temperatures", NASA CR-101942, Final Report, Battelle Memorial Institute, Contract NAS 9-7689 (March 1970).

78652 Younger, C. L. and Haley, F. A., "Irradiation Effect at Cryogenic Temperature on Tensile Properties of Titanium and Titanium-Base Alloys", Technical Memorandum NASA TM X-52772 (1970).

79301 Rawe, R. A., "Biaxial Strength of MIG- and TIG-Welded 2016-T6 at 70°, −320° and −423°F", Technical Report NASA CR-109904, Douglas Aircraft Company, Contract NAS 7-101 (May 24, 1968).

79385 Moskalenko, V. A., Puptsova, V. N., and Ul'yanov, R. A., "Strength and Ductility of Titanium Alloys at Low Temperatures", Metal Science and Heat Treatment, (6), 464-466 (June, 1970).

79561 Clark, A. F., Childs, G. E., and Wallace, G. H., "Electrical Resistivity of Some Engineering Alloys at Low Temperatures", Cryogenics, 10 (4), 295-305 (August, 1970).

79816 Hall, L. R. and Finger, R. W., "Fracture and Fatigue Growth of Partially Embedded Flaws", Proceedings of the Air Force Conference on Fatigue and Fracture of Aircraft *Structures and Materials*, 235-262 (December, 1969).

79857 Tiffany, C. F., Masters, J. N., and Bixler, W. D., "Investigation of Crack Growth Threshold of Inconel 718 Exposed to High Pressure Oxygen", Technical Report NASA CR-108485, Boeing Company, Contract NAS 9-10913 (August, 1970).

80104 Orange, T. W., Sullivan, T. L., and Calfo, F. D., "Fracture of Thin Sections Containing Through and Part-Through Cracks", ASTM Special Technical Publication 496 (August, 1971).

80755 Montano, J. W., "An Evaluation of the Mechanical and Stress Corrosion Properties of Cold Worked A-286 Alloy", NASA Technical Memorandum NASA TM X-64569 (February 12, 1971).

80994 Vishnevsky, C. and Steigerwald, E. A., "Plane Strain Fracture Toughness of Some Cryogenic Materials at Room And Subzero Temperatures", ASTM Special Technical Publication 496 (August, 1971).

80995 Nelson, F. G. and Kaufman, J. G., "Plane Strain Fracture Toughness of Aluminum Alloys at Room and Subzero Temperatures", ASTM Special Technical Publication 496 (August, 1971).

80996 Hall, L. R., "Influence of Specimen Design in Plane Strain Fracture Toughness Testing", ASTM Special Technical Publication 496 (August, 1971).

81726 Sullivan, T. L., "Behavior of Ti-5Al-2.5Sn ELI Titanium Alloy Sheet Parent and Weld Metal in the Presence of Cracks at 20°K", NASA Technical Note NASA TN D-6544 (November, 1971).

82097 Hust, J. G. and Sparks, L. L., "Thermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys From 4° to 300°K: III. Annealed Inconel 718", NBS Technical Report 9775 (November 24, 1970).

82534 Larbalestier, D. C. and King, H. W., "Non Magnetic Stainless Steels for Cryogenic Purposes", Technical Report RHEL/R 217, Imperial College, London (January, 1971).

82916 Schwartzberg, F. R., Keys, R. D., and Kiefer, T. F., "Cryogenic Alloy Screening", Interim Report NASA CR-72617, Martin Marietta Corporation, Contract NAS 3-11203 (February 1970).

82966 Malin, C. O., "Low-Temperature Properties of Large Inconel 718 Forgings", Reportable Item Submission Number MFS-18244, Rocketdyne/North American, Contract NASw-16 (June 14, 1968).

83166 Malin, C. O., "Low-Temperature Properties of Armco 21-6-9 Alloy (Cr-Ni-Mn)", Reportable Item Submission Number MFS-18243, Rocketdyne/North American (June14, 1968).

83169 Green, E. F., "Low-Temperature Properties of 18-Percent Nickel (200-Grade) Maraging Steel Plate", Reportable Item Submission Number MFS-18281, Rocketdyne/North American, Contract NASw-16 (July 3, 1968).

83417 Schmidt, E. H., "Fatigue Properties of Sheet, Bar, and Cast Metallic Materials for Cryogenic Applications", Technical Report R-7564, Rocketdyne/North American, Contract NAS 8-18734 (August 30, 1968).

83948 Montano, J. W. "The Effects of Solution Treatment on the Mechanical Properties of Age-Hardened A-286 Bar Stock at Elevated and Cryogenic Temperatures", NASA Technical Memorandum NASA TM X-64638 (February 16, 1972).

84318 Masters, J. N., Haese, W. P., and Finger, R. W., "Investigation of Deep Flaws in Thin Walled Tanks", Final Report D2-121696-1, NASA CR-72606, Boeing Company, Contract NAS 3-10290 (December, 1969).

84319 Engstrom, W. L., "Determination of Design Allowable Properties — Fracture of 2219-T87 Aluminum Alloy", Technical Report D180-14480-1, NASA CR-115388, Boeing Company, Contract NAS 9-10364 (March, 1972).

84320 Tiffany, C. F., Lorenz, P. M., and Shah, R. C., "Extended Loading of Cryogenic Tanks", Final Report, NASA CR-72252, Boeing Company, Contract NAS 3-6290 (July, 1967).

84321 Hall, L. R., and Finger, R. W., "Investigation of Flaw Geometry and Loading Effects on Plane Strain Fracture in Metallic Structures", Final Report, NASA CR-72659, Boeing Company, Contract NAS 3-12016 (December 18, 1971).

86296 Hall, L. R. and Bixler, W. D., "Subcritical Crack Growth of Selected Aerospace Pressure Vessel Materials", Technical Report D 180-14855-1, NASA CR-120834, Boeing Company Contract NAS 3-12044 (December, 1972).

87195 Hall, L. R. and Finger, R. W., "Stress Corrosion Cracking and Fatigue Crack Growth Studies Pertinent to Spacecraft and Booster Pressure Vessels", Technical Report D180-15018-1, NASA CR-120823, Boeing Company, Contract NAS 3-12003 (December, 1972).

87223 Hall, L. R. and Finger, R. W., "Fracture and Crack Growth Resistance Studies of 304 Stainless Steel Weldments Relating to Retesting of Cryogenic Vessels", Final Report, NASA CR-121025, Boeing Company, Contract NAS 3-12003 (December, 1972).

87479 Gasanov, M. A., Romashev, L. N., and Fakidov, I. G., "Magnetic Properties of Stainless Steel Kh18N10T", The Physics of Metals and Metallography, 33 (2), 190-191 (1972).

87612 Bixler, W. D., "Development of a Fracture Control Method for Composite Tanks With Load Sharing Liners", Final Report D180-15296-1, NASA CR-120918, Boeing Company, Contract NAS 3-14380 (March, 1973).

88109 Forman, R. G., Glorioso, S. V., and Medlock, J. D., "Flaw Growth Behavior in Thick Welded Plates of 2219-T87 Aluminum at Room and Cryogenic Temperatures", NASA Technical Note NASA-TN-D-7377 (August 1973).

88112 Sarno, D. A., McCabe, D. E., Sr., and Heberling, T. G., "Fatigue and Fracture Toughness Properties of 9% Nickel at LNG Temperatures", Transactions of the ASME, Series B, Journal of Engineering for Industry, 95 (4), 1069-1075 (November 1973).

88439 Reuter, W. G., "Fracture Toughness of Ti-5Al-2.5Sn ELI Forgings at −423°F", Memoranda and Material R&D Report, Aerojet-General Corporation (January 26, 1971).

89525 Naimon, E. R., Weston, W. F., and Ledbetter, H. M., "Elastic Properties of Two Titanium Alloys at Low Temperatures", Cryogenics, 14 (5), 246-249 (May, 1974).

89543 Nachtigall, A. J., "Strain-Cycling Fatigue Behavior of Ten Structural Metals Tested in Liquid Helium (4°K), in Liquid Nitrogen (78°K), and in Ambient Air (300°K)", NASA Technical Note NASA TN D-7532 (February, 1974).

89716 Masters, J. N., Bixler, W. D., and Finger, R. W., "Fracture Characteristics of Structural Aerospace Alloys Containing Deep Surface Flaws", Final Report, NASA CR-134587, Boeing Aerospace Company, Contract NAS 3-14341 (December 1973).

89983 Masters, J. N., Engstrom, W. L., and Bixler, W. D., "Deep Flaws in Weldments of Aluminum and Titanium", Final Report, NASA CR-134649, Boeing Aerospace Company, Contract NAS 3-14386 (April 1974).

90068 Schwartzberg, F., Agricola, K., and Hauser, R., "Properties of Missile Materials at Cryogenic Temperatures", Technical Report, Martin Company (May 1960).

90069 Kaufman, J. G., Nelson, F. G., and Johnson, E. W., "Properties of Aluminum Alloy 2219 Sheet, Plate, and Welded Joints at Low Temperatures", Proceedings of the 1962 Cryogenic Engineering Conference, 661-670 (1963).

90070 Kaufman, J. G., and Wanderer, E. T., "Tensile Properties and Notch Toughness of Some 7XXX Alloys at -452 F", Proceedings of the 1970 Cryogenic Engineering Conference, 27-36 (1971).

90072 Nelson, F. G., Kaufman, J. G., and Wanderer, E. T., "Tensile Properties and Notch Toughness of Groove Welds in Wrought and Cast Aluminum Alloys at Cryogenic Temperatures", Proceedings of the 1968 Cryogenic Engineering Conference, 71-82 (1969).

90073 Christian, J. L. and Watson, J. F., "Mechanical Properties of Several 2000 and 6000 Series Aluminum Alloys", Proceedings of the 1964 Cryogenic Engineering Conference, 63-76 (1965).

90075 DeMoney, F. W., "Effect of Aging on the Tensile Properties of Alloy 7039 GTA Welds at Low Temperatures", Proceedings of the 1966 Cryogenic Engineering Conference, 500-507 (1967).

90076 Hanson, M. P., Stickley, G. W., and Richards, H. T., "Sharp-Notch Behavior of Some High-Strength Sheet Aluminum Alloys and Welded Joints at 75°, –320°, and –423°F", ASTM Special Technical Publication No. 287 (June, 1960).

90078 Christian, J. L., "Mechanical Properties of Aluminum Alloys at Cryogenic Temperatures," Technical Report MRG-190, Convair-Astronautics/General Dynamics (December 2, 1960).

90079 Watson, J. F. and Christian, J. L., "Low-Temperature Properties of K-Monel, Inconel–X, Rene 41, Haynes 25, and Hastelloy B Sheet Alloys", Paper presented at the Winter Annual Meeting of the American Society of Mechanical Engineers, New York, N. Y. (November 26-December 1, 1961).

90081 Ottlyk, A. A., "Cryogenic Tensile Properties of .040 Gage 301XH Stainless Steel", Test Progress Report, SLML-60-414, EWA 59202, Boeing Company (October 28, 1960).

90082 DeMoney, F. W., "Proposed Case for Aluminum Alloy 7039-T61 &-T6151", submitted to the ASME Boiler & Pressure Vessel Code Committee (October 24, 1963).

90083 DeMoney, F. W. and Wolfer, G. C., "The Fatigue Properties of Aluminum Alloy 5083-H113 Plate and Butt Weldments at 75°F and –300°F", Paper presented at the 1960 Cryogenic Engineering Conference, Boulder, Colorado (August, 1960).

90084 Anon., "Weldable/Heat-Treatable Aluminum Alloy 7039", Manufacturers' Literature, Kaiser Aluminum & Chemical Corporation (June, 1965).

90087 Larbalestier, D. C. and King, H. W., "Austenitic Stainless Steels at Cryogenic Temperatures. 1-Structural Stability and Magnetic Properties", Cryogenics, 13 (3), 160-168 (March, 1973).

90104 Morgan, W. R., "Low Temperature Mechanical Properties of Inconel 718 and AM 355", Internal Note IN-P&VE-M-66-2, NASA George C. Marshall Space Flight Center (January 31, 1966).

90107 Morgan, W. R., "Low Temperature Mechanical Properties of Aluminum Alloy 7039-T6 Sheet and Plate", Internal Note IN-P&VE-M-66-6, NASA George C. Marshall Space Flight Center (November 14, 1966).

90111 Goodzeit, C. L., "Optimization of Gas-Cooled Superconducting Magnet Leads. A Method for General Materials", Informal Report BNL 17233, PDD-72-1, Brookhaven National Laboratory (September 18, 1972).

90115 Killpatrick, D. H., Corn, D. L., and Stoeckinger, G. R., "Cryogenic Fracture Toughness of 18 Nickel 200-Grade Maraging Steel Plate and Welds", MDAC Paper WD 2030 presented to the American Society of Metals 1973 Western Conference, Los Angeles, California (March 12, 1973).

90117 Davis, R. J., and France, E. J., "Cryogenic Tensile Properties of Ti-6Al-4V Forgings", Industrial Applications Flash Sheet MFS-12533, Douglas Aircraft Company, Contract NAS 7-101 (November 8, 1966).

90123 Hull, F. C., "Cryogenic Tensile Properties of Cold Rolled Kromarc 58 Stainless Steel Sheet", Technical Research Report 67-1D6-KROMA-R1, Westinghouse Research Laboratories (May 23, 1967).

90125 Park, O. E., Fulk, M. M., and Reynolds, M. M., "Low Temperature Electrical Resistance of Fifteen Commercial Conductors", Proceedings of the 1954 Cryogenic Engineering Conference, 101-102 (1955).

90133 Koshelev, P. F., Mikheev, V. S., and Nikitin, P. N., "The Mechanical Properties of Titanium Alloys With Vanadium and Columbium at Low Temperatures", Metal Science and Heat Treatment, 14 (2), 111-113 (February, 1972).

90159 Geil, G. W. and Carwile, N. L., "Tensile Properties of Copper, Nickel, and Some Copper-Nickel Alloys at Low Temperatures", NBS Circular 520, 67 (May 7, 1952).

90164 Clark, A. F. and Tryon, P. V., "Material Variability as Measured by Low Temperature Electrical Resistivity", Cryogenics, 12 (6), 451-461 (December, 1972).

90169 Lenhart, H. G., "Cryogenic Research – Tensile Properties of 2219-T87 Aluminum Alloy Plate at Room and Cryogenic Temperatures", Test Progress Report SLML-60-473, Boeing Company (December 6, 1960).

90170 Childs, G. E., Ericks, L. J., and Powell, R. L., "Thermal Conductivity of Solids at Room Temperature and Below. A Review and Compilation of the Literature", NBS Monograph 131 (September, 1973).

90171 Hooper, A. F., and Christian, J. L., "Mechanical Properties of Titanium 5Al-2.5Sn Alloy at Room and Cryogenic Temperatures", Technical Report, General Dynamics, Contract AF 33(616)-7984 (March 1963).

90172 Anon., "Determination of Design Data for Heat-Treated Titanium Alloy Sheet. Volume 3. Tables of Data Collected", Technical Report ASD-TDR-62-335 V3, Lockheed Aircraft Corporation, Contract AF 33(616)-6346 (December 1962).

90174 Bogardus, K. O. and Malcolm, R. C., "Design Stresses for 5083-0 and 5183 Welds at Cryogenic Temperatures", Manuscript submitted for publication by ASTM (received during June, 1974).

90175 Kelsey, R. A., Nordmark, G. E., and Clark, J. W., "Fatigue Crack Growth in Aluminum Alloy 5083-0 Thick Plate and Welds for Liquefied Natural Gas Tanks", ASTM Special Technical Publication 556, 159-185 (July 1974).

90176 Kaufman, J. G., Nelson, F. G., and Wygonik, R. H., "Large Scale Fracture Toughness Tests of Thick 5083-0 Plate and 5183 Welded Panels at Room Temperature, −260°, and −320°F", ASTM Special Technical Publication 556, 125-158 (July, 1974).

90178 Hall, L. A., "Survey of Electrical Resistivity Measurements on 16 Pure Metals in the Temperature Range 0° to 273°K", NBS Technical Note 365 (February, 1968).

90180 Morgan, W. R., "Mechanical Properties of 2219-T87 Alloy Plate at Room and Cryogenic Temperatures", Internal Note IN-P&VE-M-62-9, NASA George C. Marshall Space Flight Center (October 5, 1962).

90181 Morgan, W. R., "Low Temperature Mechanical Properties of K-Monel Alloy and Its Weldments", Internal Note IN-P&VE-M-62-8, NASA George C. Marshall Space Flight Center (August 28, 1962).

90183 Lovoy, C. V., "Low Temperature Mechanical Properties of X-2020-T6 and 2219-T6 Aluminum Sheet Alloys", Internal Note IN-P&VE-M-62-3, NASA George C. Marshall Space Flight Center (May 5, 1962).

90184 Cataldo, C. E., "Weldability Studies of 5456-H343 and 2219-T87 Aluminum Alloy Plates", Internal Note IN-P&VE-M-62-2, NASA George C. Marshall Space Flight Center (April 2, 1962).

90185 Christian, J. L., and Hurlich, A., "Mechanical Properties of Titanium Alloys at Cryogenic Temperatures", Proceedings of the 1967 Cryogenic Engineering Conference, 318-333 (1968).

90187 Lake, R. L., DeMoney, F. W., and Eiber, R. J., "Burst Tests of Pre-Flawed Welded Aluminum Alloy Pressure Vessels at -220 F", Proceedings of the 1967 Cryogenic Engineering Conference, 278-293 (1968).

90188 Kaufman, J. G., and Johnson, E. W., "Notch Sensitivity of Aluminum Alloy Sheet and Plate at -320 F Based Upon Notch-Yield Ratio", Proceedings of the 1962 Cryogenic Engineering Conference, 678-685 (1963).

90189 DeMoney, F. W. and Wolfer, G. C., "Tensile and Impact Properties of 7075-T6 and 7079-T6 Plate, Hand Forgings, and Tensile Properties of Plate MIG Weldments Between 75° and −320°F", Proceedings of the 1961 Cryogenic Engineering Conference, 466-477 (1962).

90190 Rice, L. P., Campbell, J. E., and Simmons, W. F., "Tensile Behavior of Parent Metal and Welded 5000-Series Aluminum-Alloy Plate at Room and Cryogenic Temperatures", Proceedings of the 1961 Cryogenic Engineering Conference, 478-489 (1962).

90193 Hust, J. G., "Thermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys from 4 to 300 K - II. AISI 347 Stainless Steel", Technical Report 9772, NBS (October 27, 1970).

90194 Hust, J. G. and Sparks, L. L., "Thermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys From 4° to 300°K: IV. A-286 Stainless Steel", Technical Report 9789, NBS (April 6, 1971).

90195 Hust, J. G., and Sparks, L. L., "Thermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys from 4 to 300 K: V. Aluminum 2024", Technical Report 9790, NBS (April 8, 1971).

90200 Bowers, W. D., "Cryogenic Tensile Properties of Inconel 718", Technical Report M-2131, Aerojet-General Corporation (April 18, 1963).

90202 VanReuth, E. C. and Reed, R. P., "Materials Research in Support of Superconducting Machinery", Semi-Annual Technical Report for September 1, 1973 to March 1, 1974 (March, 1974).

90203 Kaufman, J. G., "Mechanical Properties of Plain and Welded 6061 Aluminum Alloy at Subzero Temperatures", Technical Report 9-60-26, Aluminum Company of America (July 1960).

90205 Schramm, R. E., Clark, A. F., and Reed, R. P., "A Compilation and Evaluation of Mechanical, Thermal, and Electrical Properties of Selected Polymers", NBS Monograph 132 (September, 1973).

90206 Hall, L. A. and Germann, F.E.E., "Survey of Electrical Resistivity Measurements on 8 Additional Pure Metals in the Temperature Range 0° to 273°K", Technical Note 365-1, NBS (August, 1970).

90208 Corruccini, R. J. and Gniewek, J. J., "Thermal Expansion of Technical Solids at Low Temperatures", National Bureau of Standards Monograph 29 (May 19, 1961).

90209 Fickett, F. R., "Aluminum. 1. A Review of Resistive Mechanisms in Aluminum", Cryogenics, 11 (5), 349-367 (October 1971).

90214 McCammon, R. D., and Rosenberg, H. M., "The Fatigue and Ultimate Tensile Strengths of Metals Between 4.2 and 293 K", Proceedings of the Royal Society (London), A242, 203-211 (1957).

90217 White, G. K., and Woods, S. B., "Electrical and Thermal Resistivity of the Transition Elements at Low Temperatures", Philosophical Transactions of the Royal Society of London, A251 (995), 273-302 (1959).

90218 Rhodes, B. L., Moeller, C. E., and Sauer, H. J., "An Apparatus for Determining Thermal Conductivity of Solids From 20° to 600°K", Cryogenics, 5 (1), 17-20 (February, 1965).

90219 De Nobel, J., "Heat Conductivity of Steels and a Few Other Metals at Low Temperatures", Physica, 17 (5), 551-562 (May 1951).

90220 Betty, B. B. and Mudge, W. A., "Some Engineering Properties of Nickel and High-Nickel Alloys", Mechanical Engineering, 67 (2), 123-129 (February, 1945).

90223 Touloukian, Y. S. and Buyco, E. H., "Thermophysical Properties of Matter. Volume 4. Specific Heat, Metallic Elements, and Alloys", Plenum Press, N. Y. (1970).

90224 Touloukian, Y. S., Powell, R. W., Ho, C. Y., and Klemens, P. G., "Thermophysical Properties of Matter, Volume 1. Thermal Conductivity, Metallic Elements and Alloys", Plenum Press, N. Y. (1970).

90225 Powell, R. L., Hall, W. J., and Roder, H. M., "Low-Temperature Transport Properties of Commercial Metals and Alloys. II. Aluminums", Journal of Applied Physics, 31 (3), 496-503 (March, 1960).

90226 Johnston, H. L., Altman, H. W., and Rubin, T., "Coefficients of Thermal Expansions of Alloys at Low Temperatures", Journal of Chemical and Engineering Data, 10 (3), 241-242 (1965).

90230 Hust, J. G., "Thermal Conductivity Standard Reference Materials from 4 to 300 K. I. Armco Iron", Technical Report 9740, NBS (August 1969).

90244 Connella, M. J., Deck, R. J., and Morriss, R. H., "Microstructural Effects in Critical Fields of Niobium Films", Jounal of Applied Physics, 41 (13), 5346-5348 (December, 1970).

90247 Osborne, D. W., Flotow, H. E., and Schreiner, F., "Calibration and Use of Germanium Resistance Thermometers for Precise Heat Capacity Measurements from 1 to 25 K. High Purity Copper for Interlaboratory Heat Capacity Comparisons", The Review of Scientific Instruments, 38 (2), 159-168 (February 1967).

90249 Martin, D. L., "Specific Heats of Copper, Silver, and Gold Below 30 K", Physical Review, 141 (2), 576-582 (January 1966).

90252 Hahn, T. A., "Standards, Copper, Methods. Thermal Expansion of Copper From 20° to 800°K – Standard Reference Material 736", Jounal of Applied Physics, 41 (13), 5096-5101 (December, 1970).

90259 Chang, Y. A. and Hultgren, R., "The Dilation Contribution to the Heat Capacity of Copper and Alpha-Brass at Elevated Temperatures", The Journal of Physical Chemistry, 69 (12), 4162-4165 (December, 1965).

90265 Upthegrove, C. and Burghoff, H. L., "Elevated-Temperature Properties of Coppers and Copper-Base Alloys", ASTM Special Technical Publication No. 181 (1956).

90300 Powell, R. L., Roder, H. M., and Rogers, W. M., "Low-Temperature Thermal Conductivity of Some Commercial Coppers", Journal of Applied Physics, 28 (11), 1282-1288 (November 1957).

90302 McClintock, R. M., Van Gundy, D. A., and Kropschot, R. H., "Low-Temperature Tensile Properties of Copper and Four Bronzes", ASTM Bulletin, (240), 47-50 (September, 1959).

90306 Mikheyev, V. S., Pustovoytova, T. G., Sokolov, V. S., and Shnyrev, G. D., "Strength and Ductility of Ti-Nb-Zr Alloys at −196°C and at +20°C", Russian Metallurgy (Izv. Akad. Nauk SSSR Metal.) (4), 125-126 (1970).

90310 Alekseevskii, N. E., Dubrovin, A. V., Mikhailov, N. N., Sokolov, V. I., and Fedotov, L. N., "Principal Properties of Superconducting Wire Made From an Alloy of the 65BT Type in Samples and Solenoids", Soviet Physics-Doklady, 11 (11), 993-996 (May, 1967).

90314 Rayne, J. A., "Heat Capacity of Alpha Brasses Below 4.2 K", Physical Review, 108 (1), 22-25 (October 1, 1957).

90317 Kemp, W.R.G., Klemens, P. G., Tainsh, R. J., and White, G. K., "The Electrical and Thermal Conductivities of Some Brasses at Low Temperatures", Acta Metallurgica, 5 (6), 303-309 (June 1957).

90318 Estermann, I. and Zimmerman, J. E., "Heat Conduction in Alloys at Low Temperatures", Journal of Applied Physics, 23 (5), 578-588 (May, 1952).

90322 Powell, R. L., Roder, H. M., and Hall, W. J., "Low-Temperature Transport Properties of Copper and Its Dilute Alloys: Pure Copper, Annealed and Cold-Drawn", Physical Review, 115 (2), 314-323 (July 15, 1959).

90323 Gibbons, D. F., "Thermal Expansion of Some Crystals with the Diamond Structure", Physical Review, 112 (1), 136-140 (October 1, 1958).

90328 Phillips. N. E., "Heat Capacity of Aluminum Between 0.1°K and 4.0°K", Physical Review, 114 (3), 676-685 (May 1, 1959).

90336 Beenakker, J.J.M., and Swenson, C. A., "Total Thermal Contractions of Some Technical Metals to 4.2°K", Review of Scientific Instruments, 26 (12), 1204-1205 (December, 1955).

90339 Martin, D. L., "The Specific Heat of Copper From 20° to 300°K", Canadian Journal of Physics, 38 (1), 17-24 (1960).

90341 Radhakrishna, P., and Nielsen, M., "Thermal Conductivity of Niobium-Zirconium Alloys at Low Temperatures", Physics Letters, 6 (1), 36-38 (August 15, 1963).

90347 Van Der Hoeven, J. C., Jr. and Keesom, P. H., "Specific Heat of Niobium Between 0.4° and 4.2°K", Physical Review, 134 (5A), A1320-A1321 (June 1, 1964).

90348 Henry, W. G., and Schroeder, P. A., "The Low-Temperature Resistivities and Thermopowers of Alpha-Phase Copper-Zinc Alloys", Canadian Journal of Physics, 41, 1076-1093 (1963).

90355 Richards, J. T., and Brick, R. M., "Mechanical Properties of Beryllium Copper at Subzero Temperatures", Journal of Metals, 6 (5), 574-580 (May, 1954).

90366 Fraser, D. B. and Hallett, A.C.H., "The Coefficient of Thermal Expansion of Various Cubic Metals Below 100°K", Canadian Journal of Physics, 43 (2), 193-219 (February, 1965).

90370 Dixon, M., Hoare, F. E., Holden, T. M., and Moody, D. E., "The Low Temperature Specific Heats of Some Pure Metals (Cu, Ag, Pt, Al, Ni, Fe, Co)", Proceedings of the Royal Society London, A285 (1403), 561-580 (1965).

90375 Reed, R. P. and Mikesell, R. P., "Low-Termperature (295° to 4°K) Mechanical Properties of Selected Copper Alloys", Journal of Materials, 2 (2), 370-392 (June, 1967).

90447 Cheeke, J.D.N., Hebral, B., and Richard, J., "Kapitza Resistance Between the Transition Metals Fe, Co, and Ni and Superfluid Helium", Journal of Low Temperature Physics, 12 (3/4), 359-373 (1973).

90458 Bijl, D. and Pullan, H., "A New Method for Measuring the Thermal Expansion of Solids at Low Temperatures: The Thermal Expansion of Copper and Aluminum and the Gruneisen Rule", Physica, 21, 285-298 (1955).

90459 Rubin, T., Altman, H. W., and Johnston, H. L., "Coefficients of Thermal Expansion of Solids at Low Temperatures. I. The Thermal Expansion of Copper From 15° to 300°K", American Chemical Society, 76, 5289-5293 (November 5, 1954).

90467 Hurd, C. M., "A Magnetic Susceptibility Apparatus for Weakly Magnetic Metals, and the Susceptibility of Pure Copper in the Range 6°-300°K", Cryogenics, 6 (5), 264-269 (October, 1966).

90476 Pugh, E. W., Coles, B. R., Arrott, A., and Goldman, J. E., "Magnetic Susceptibility of Dilute Alloys of Nickel In Copper Between 2.5°K and 295°K", Physical Review, 105 (3), 814-818 (February 1, 1957).

90477 Van Itterbeek, A., and Duchateau, W., "Measurements on the Magnetic Susceptibility of White Tin and Copper Down to Liquid Helium Temperatures", Physica, 23, 169-172 (1957).

90491 Pugh, E. W. and Ryan, F. M., "Magnetic Susceptibility of Copper-Nickel and Silver-Palladium Alloys at Low Temperatures", Physical Review, 111 (4), 1038-1042 (August 15, 1958).

90493 Blythe, H. J., Holden, T. M., Dixon, M., and Hoare, F. E., "The Magnetic and Thermal Properties of Some Aluminum-Rich Binary Alloys", Philosophical Magazine, Series 8, 11 (110), 235-250 (February, 1965).

90494 Kondorskii, E. I. and Sedov, V. L., "Antiferromagnetism of the Gamma Phase of Iron", Soviet Physics (JETP), 8 (35), 1104-1105 (1959).

90499 Sekula, S. T. and Boom R. W., "Longitudinal Critical Currents in Cold-Drawn Superconducting Alloys", Applied Physics Letters, 2 (5), 102-104 (March 1, 1963).

90524 Larbalestier, D. C. and King, H. W., "Problems With Stainless Steel Formers for Superconducting Magnets", Cryogenics, 10 (5), 410-412 (October, 1970).

90537 Anon., "9% Nickel Steel for Low Temperature Service", Manufacturers' Literature, A-263, 5M 10-73 (5C 1-72) 3749, International Nickel Company, Incorporated (no date given).

90624 McDaniel, R. H., Bradford, E. W., Lewis, J. H., and Wattier, J. B., "NERVA Irradiation Program—GTR 23- Volume I—Combined Effects of Reactor Radiation and Cryogenic Temperature on NERVA Structural Materials", NASA CR-137267, General Dynamics Corporation, Contract AF 29(601)-7077 (January, 1973).

90717 Forman, R. G., "Crack-Growth Behavior in Thick Welded Plates of Inconel 718 at Room and Cryogenic Temperatures", NASA Technical Note, NASA TN D-7665, Lyndon B. Johnson Space Center (May 1974).

91494 Jin, S., Hwang, S. K., and Morris, J. W., Jr., "Comparative Fracture Toughness Testing of Cryogenic Alloys at Liquid Helium Temperature", Technical Report TR-5, University of California, Contract N00014-69-A-0200-1062 (August 1974).

91696 Shah, R. C., "Effects of Proof Loads and Combined Mode Loadings on Fracture and Flaw Growth Characteristics of Aerospace Alloys", NASA CR-134611, Technical Report D180-17997-1, Boeing Company, Contract NAS 3-14346 (March 1974).

91793 Van Stone, R. H., Low, J. R., Jr., and Shannon, J. L., Jr., "The Effect of Microstructure on the Fracture Toughness of Titanium Alloys", NASA Technical Report 2-Ti, Carnegie-Mellon University, NASA Research Grant 39-087-047 (December 1974).

91978 Haynes, A. G., Firth, K., Hollox, G. E., and Buchan, J., "Strength and Fracture Toughness of Nickel Containing Steels, ASTM STP 579, 288-323 (1975).

92996 Pense, A. W. and Stout, R. D., "Fracture Toughness and Related Characteristics of the Cryogenic Nickel Steels", WRC Bulletin, No. 205, 1-43 (May, 1975).

93338 Witzell, W. E., "Crack Growth Behavior of 2219-T87 Aluminum Alloy from 20 K (-423 F) to 422 K (300 F)", CASD-NAS-73-011, NASA CR-134047, General Dynamics, Contract NAS 9-12445 (August 1973).

94195 Fedorov, G. V. and Ryabinina, N. M., "Hall Effect, Magnetic Susceptibility and Resistivity of Cu-Ni Alloys", Physics of Metals And Metallography, 29 (1), 82-86 (1970).

94196 Furukawa, G. T., McCoskey, R. E., and King, G. J., "Calorimetric Properties of Polytetrafluoroethylene(Teflon) From 0° to 365°K", Journal of Research of the National Bureau of Standards, 49 (4), 273-278 (October, 1952).

94197 Jin, S., Morris, J. W., Jr., and Zackay, V. F., "An Iron-Nickel-Titanium Alloy With Outstanding Toughness at Cryogenic Temperatures", Advances in Cryogenic Engineering, 19, 379-384 (1974).

94198 Tucker, J. E., "Heat Capacity on Polyethylene in the Temperature Range of 2.4° to 30°K", Doctorial Thesis, U.S. Naval Postgraduate School (May, 1966).

94199 Warfield, R. W. and Petree, M. C., "Thermodynamic Properties of Polyethylene", Technical Report NOLTR 61-92, U.S. Naval Ordinance Laboratory (October, 1961).

94200 Warfield, R. W. and Petree, M. C., "Thermodynamic Properties of Polystyrene and Styrene", NAVWEPS Report 7352, U.S. Naval Ordinance Laboratory (September 21, 1960).

94201 Warfield, R. W. and Petree, M. C., "Thermodynamic Properties of Polymethyl Methacrylate and Methyl Methacrylate", NOLTR 62-98, U.S. Naval Ordinance Laboratory (January 17, 1962).

94202 Mowers, R. E., "Program of Testing Nonmetallic Materials at Cryogenic Temperatures", Final Report, Technical Documentary Report RTD-TDR-63-11, Rocketdyne/North American Aviation, Incorporated, Contract AF 04(611)-6354 (December 30, 1962).

94203 Wunderlich, B., "Heat Capacities of Linear High Polymers", Technical Report No. i7, Rensselaer Polytechnic Institute, Contract Nonr-591(19) (November, 1968).

94204 Hurlich, A. and Scheck, W. G., "Evaluation and Application of Stainless Steels in Cryogenic Environments", Advances in the Technology of Stainless Steels and Related to Alloys, ASTM Special Technical Publication No. 369, 127-135 (1963).

94205 Brickner, K. G., "Stainless Steels for Room And Cryogenic Temperatures", Metals Engineering Quarterly, 8 (2), 1-29 (May, 1968).

94206 Clark, A. F., Reed, R. P., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-II", Second Semi-Annual Technical Report, NBS (March 1, 1974—September 1, 1974).

94206A Schwartzberg, F. R., "Study of Fracture Behavior of Metals for Superconducting Applications", Second Annual Technical Report MCR-74-89, Martin Marietta Corporation (October, 1974).

94206B Tobler, R. L., Mikesell, R. P., Durcholz, R. L., and Reed, R. P., "Fatigue and Fracture Toughness Testing at Cryogenic Temperatures", Semi-Annual Report, NBS (October, 1974).

94206C Ledbetter, H. M., Naimon, E. R., and Weston, W. F., "Elastic Properties of Engineering Materials at Cryogenic Temperatures", Semi-Annual Report, NBS (October, 1974).

94206D Naimon, E. R., Weston, W. F., and Ledbetter, H. M., "Elastic Properties of Two Titanium Alloys at Low Temperatures", Cryogenics, 14, 246-249 (1974).

94206E Lessmann, G. G., Kossowsky, R., Logsdon, W. A., et al, "Structural Materials For Cryogenic Applications", Second Semi-Annual Technical Report, Westinghouse Electric Corporation (September 9, 1974).

94207 Ledbetter, H. M., Naimon, E. R., and Weston, W. F., "Low-Temperature Elastic Properties of Invar", Paper D-3 presented at the Cryogenic Engineering—International Cryogenics Materials Joint Conference, Queens University, Kingston, Canada (July 22-25, 1975).

94208 Reed, R. P., Clark, A. F., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-III", Third Semi-Annual Technical Report, NBS-ARPA (September 1, 1974—March 1, 1975).

94208A Schwartzberg, F. R. and Kiefer, T., "Study of Fracture Behavior of Metals for Superconducting Applications", Semi-Annual Technical Report, MCR-74-89 (Issue 3), Martin Marietta Corporation (April, 1975).

94208B Fowlkes, C. W. and Tobler, R. L., "Fracture Testing and Results for a Ti-6Al-4V Alloy at Liquid Helium Temperature", Technical Report, NBS (1974).

94208C Tobler, R. L., "Fatigue Crack Growth and J—Integral Fracture Parameters of Ti-6Al-4V at Ambient and Cryogenic Temperatures", Technical Report, NBS (1974).

94208D Tobler, R. L. and Reed, R. P., "Fatigue Crack Growth Rates of Structural Alloys at Four Kelvin", Technical Report, NBS (1974-1975).

94208E Reed, R. P., Tobler, R. L., and Mikesell, R. P., "The Fracture Toughness and Fatigue Crack Growth Rate of an Fe-Ni-Cr Superalloy at 298°, 76° and 4°K", Technical Report, NBS (1974-1975).

94208F Weston, W. F. and Ledbetter, H. M., "Low-Temperature Elastic Properties of a Nickel-Chromium-Iron-Molybdenum Alloy", Technical Report, NBS (1974-1975).

94208G Wells, J. M., Kossowsky, R., Logsdon, W. A., and Daniel, M. R., "Structural Materials for Cryogenic Applications", Third Semi-Annual Technical Report, Westinghouse Electric Corporation (March 10, 1975).

829

95168 Clark, A. F., Reed, R. P., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-IV", Fourth Semi-Annual Technical Report, National Bureau of Standards (October 1975).

96682 McRickard, S. B., "Twinning Deformation in Iron at 4 K", Physica Status Solidi, 18 (1), 89-97 (November 1, 1966).

96683 Lismer, R. E., "Properties of Some Alloys and Weld Metal Deposits at Low Temperatures", Welding and Metal Fabrication, 30 (1), 19-27 (January 1962).

96684 Murayama, N., Pense, A. W., and Stout, R. D., "The Fracture Toughness of Cryogenic Steels", Paper F-2 presented at the Cryogenic Engineering - International Cryogenics Materials Joint Conference, Queens University, Kingston, Canada (July 22-25, 1975).

96685 Carman, C. M., and Katlin, J. M., "Plane Strain Fracture Toughness and Mechanical Properties of 5Al-2.5Sn ELI and Commercial Titanium Alloys at Room and Cryogenic Temperatures", ASTM STP 432, 124-144 (1968).

96686 Bucci, R. J., Greene, B. N., and Paris, P. C., "Fatigue Crack Propagation and Fracture Toughness of 5Ni and 9Ni Steels at Cryogenic Temperatures", ASTM STP 536, 206-228 (1973).

96687 Sarno, D. A., Bruner, J. P., and Kampschaefer, G. E., "Fracture Toughness of 5% Nickel Steel Weldments", Welding Journal, 39 (11), 486s-494s (November 1974).

96688 Lismer, R. E., "The Properties of Some Metals and Alloys at Low Temperatures", Journal of the Institute of Metals, 89, 145-161 (1960/1961).

96690 Kelsey, R. A., Wygonik, R. H., and Tenge, P., "Crack Growth and Fracture of Thick 5083-0 Plate Under Liquefied Natural Gas Ship Spectrum Loading", ASTM STP 579, 44-79 (1975).

96691 Person, N. L., and Wolfer, G. C., "Fatigue Crack Growth Rate of Thick 5083-0 Plate at Room and Low Temperatures", ASTM STP 579, 80-95 (1975).

96694 Zinkham, R. E., and Ashton, R. F., "Strength and Fracture of 5083-0 Aluminum Weldments", ASTM STP 579, 159-175 (1975).

96699 Tobler, R. L., Mikesell, R. P., Burcholz, R. L., and Reed, R. P., "Low Temperature Fracture Behavior of Iron-Nickel Alloy Steels", ASTM STP 579, 261-287 (1975).

96700 Nachtigall, A. J., "Strain-Cycling Fatigue Behavior of Ten Structural Metals Tested in Liquid Helium, Liquid Nitrogen, and Ambient Air", ASTM STP 579, 378-396 (1975).

96871 Efferson, K. R., and Leonard, W. J., "Magnetic Properties of Some Structural Materials Used in Cryogenic Applications", Report ORNL-4150, Oak Ridge National Lab, Contract W-7405-ENG-26 (September 1967).

96872 Chou, C. L., Salinger, G. L., and Chiang, Y. C., "Thermal Conductivity of Some Amorphous Polymers Below 4 K", Journal of Applied Physics, 41 (2), 597-603 (February 1970).

96873 Bowers, R., "Magnetic Susceptibility of Copper Metal at Low Temperatures", Physical Review, 102 (6), 1486-1488 (June 15, 1956).

96874 Collings, E. W., Hedgcock, F. T., et al, "Magnetic and Electrical Properties of Some Ternary Mg-Mn-Al Alloys at Low Temperatures", Philosophical Magazine, Series 8, 10 (103), 159-167 (July 1964).

96875 Linz, R. J., Bouley, A. C., Klaffky, R. W., et al, "The Electrical and Thermal Conductivities of Cu-4, 10, and 20 At. % Ni from 1-25 K", IEEE Transactions on Magnetics, MAG-11 (2), 305-308 (March 1975).

96876 Morin, F. J., Maita, J. P., Williams, H. J., et al, "Heat Capacity Evidence for a Large Degree of Superconductivity in V_3Ga in High Magnetic Fields", Physical Review Letters, 8 (7), 275-277 (April 1, 1962).

96877 Fulkerson, W., Moore, J. P., and McElroy, D. L., "Comparison of the Thermal Conductivity, Electrical Resistivity, and Seebeck Coefficient of a High-Purity Iron and an Armco Iron to 1000 C", Journal of Applied Physics, 37 (7), 2639-2653 (June 1966).

96878 Vold, C. L., and Richards, L. E., "Low Temperature Thermal Expansion of A-15 Vanadium-Gallium Alloys", Materials Research Bulletin, 9 (2), 83-88 (February 1974).

96879 Golovashkin, A. I., Levchenko, I. S., Leskova, T. A., et al, "Optical and Electrical Properties of Cast, Superconducting Alloys of Vanadium-Gallium", Physics of Metals and Metallography, 36 (6), 56-65 (1973).

96880 Reese, W., "Low-Temperature Thermal Conductivity of Amorphous Polymers: Polystyrene and Polymethylmethacrylate", Journal of Applied Physics, 37 (2), 864-868 (February 1966).

96881 Reese, W., and Tucker, J. E., "Thermal Conductivity and Specific Heat of Some Polymers Between 4.5 K and 1 K", Journal of Chemical Physics, 43 (1), 105-114 (July 1, 1965).

96882 Reese, W., Higgins, P. J., and Rostine, G. W., "Effects of Radiation-Induced Cross-Links on the Low-Temperature Thermal Properties of Polystyrene", Journal of Applied Physics, 39 (3), 1800-1802 (February 15, 1968).

96883 McCammon, R. D., and Saba, R. G., "Dielectric Properties of Polystyrene and Some Polychlorostyrenes from 4 K to Room Temperature", Journal of Polymer Science, Part A-2, 7, 1721-1733 (1969).

96884 Gupta, K. P., Cheng, C. H., and Beck, P. A., "Low-Temperature Specific Heat of F.C.C. Alloys of 3d-Transition Elements", Journal of Physics and Chemistry of Solids, 25, 73-83 (1964).

96885 Hust, J. G., Weitzel, D. H., and Powell, R. L., "Thermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys from 4 to 300 K", Journal of Research of the National Bureau of Standards, Applied Physics and Chemistry, 75A (4), 269-277 (July-August 1971).

96886 Meaden, G. T., Electrical Resistance of Metals, Plenum Press, New York (1965).

96887 Fickett, F. R., "A Preliminary Investigation of the Behavior of High Purity Copper in High Magnetic Fields", Annual Report, INCRA Project No. 186, NBS, International Copper Research Association (June 1972).

96888 Reed, R. P., Ledbetter, H. M., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-V", Fifth Semi-Annual Technical Report, National Bureau of Standards (April 1976).

96889 Galstan, G. N., "Effects of Polymer Chain Orientation Upon the Thermal Conductivity of Polymethyl Methacrylate at Liquid Nitrogen Temperatures", Doctoral Thesis, U. S. Naval Postgraduate School (May 1966).

96890 Hurd, C. M., "Low Temperature Magnetic Susceptibility of Pyrex, Fused Quartz, and Polytetrafluoroethylene", Review of Scientific Instruments, 37 (4), 515-516 (April 1966).

BIBLIOGRAPHY

7010 Spretnak, J. W., Fontana, M. G., and Brooks, H. E., "Notched and Unnotched Tensile and Fatigue Properties of Ten Engineering Alloys at 25°C and -196°C", Transactions of the ASM, 43, 547-570 (1951).

8472 Mendelssohn, K., and Rosenberg, H. M., "The Thermal Conductivity of Metals at Low Temperatures. II. The Transition Elements", Proceedings of the Physical Society (London), A65, Part 6, 388-394 (June 1, 1952).

11953 Mendelssohn, K., and Rosenberg, H. M., "The Thermal Conductivity of Metals at Low Temperatures. I. The Elements of Groups 1, 2 and 3", Proceedings of the Physical Society (London), A65, Part 6, 385-388 (June 1, 1952).

26638 Kemp, W.R.G., Klemens, P. G., and White, G. K., "Thermal and Electrical Conductivities of Iron, Nickel, Titanium, and Zirconium at Low Temperatures", Australian Journal of Physics, 9 (2), 180-188 (June 1956).

29424 Lucks, C. F., and Deem, H. W., "Thermal Properties of Thirteen Metals", American Society for Testing Materials, ASTM Special Technical Publication No. 227 (February 1958).

29830 McGee, R. L., and Campbell, J. E., "The Mechanical Properties of Certain Aircraft Structural Metals at Very Low Temperatures", Technical Report ASD-TR-58-386, Battelle Memorial Institute (November 1958).

32438 Furman, D. E., "Thermal Expansion Characteristics of Stainless Steels Between -300° and 1000°F", Journal of Metals, 188 (4), 688-691 (April 1950).

32444 Krivobok, V. N., "Properties of Austenitic Stainless Steels at Low Temperatures", National Bureau of Standards Circular 520, 112-136 (May 7, 1952).

33262 Baughman, R. A., "Gas Atmosphere Effects on Materials", Final Report, R59FPD456, General Electric Company, WPAFB Contract AF 33(616)-5667 (June 15, 1959).

34348 Armstrong, T. N., Gross, J. H., and Brien, R. E., "Properties Affecting Suitability of 9 Percent Nickel Steel for Low-Temperature Service", Welding Journal Research Supplement, 38, 57-s through 70-s (February 1959).

35502 Krivobok, V. N., and Thomas, R. D., Jr., "Impact Tests of Welded Austenitic Stainless Steel", Welding Journal Research Supplement, 29 (9), 493s-495s (September 1950).

35611 Belton, J. H., Godby, L. L., and Taft, B. L., "Materials for Use at Liquid Hydrogen Temperatures", Paper presented at the Sixty-Third Annual ASTM Meeting, Atlantic City, N. J., June 26-July 1, 1963.

36268 Anon., "Properties of Titanium Alloys at Cryogenic Temperatures", Convair-Astronautics/General Dynamics, Paper presented at the MAB Meeting (January 1960).

36821 DeSisto, T. S., "The True-Stress True-Strain Properties of Titanium and Titanium Alloys as a Function of Temperature and Strain Rate", Technical Report WAL TR-405.2/4, Watertown Arsenal (March 1960).

37146 Rice, L. P., Campbell, J. E., and Simmons, W. F., "The Evaluation of the Effects of Very Low Temperatures on the Properties of Aircraft and Missile Metals", WADD-TR-60-254, Battelle Memorial Institute, Contract AF 33(616)-6345 (June 1960).

37607 Espey, G. B., Jones, M. H., and Brown, W. F., Jr., "Sharp-Edge-Notch Tensile Characteristics of Several High-Strength Titanium Sheet Alloys at Room and Cryogenic Temperatures", ASTM Special Technical Publication No. 287, 74-107 (June 30, 1960).

38292 Watson, J. F., and Christian, J. L., "The Effect of Cryogenic Temperatures on the Mechanical Properties of High Strength Sheet Alloys (Nonferrous Alloys)", Technical Report ERR-AN-002, Convair-Astronautics/General Dynamics (April 13, 1960).

38372 Watson, J. F., and Christian, J. L., "Low-Temperature Properties of Cold-Rolled AISI Types 301, 302, 304ELC, and 310 Stainless Steel Sheet", ASTM Special Technical Publication No. 287, 170-195 (June 30, 1960).

38611 Belton, J. H., Godby, L. L., and Taft, B. L., "Materials for Use at Liquid Hydrogen Temperature", ASTM Special Technical Publication No. 287, 108-121 (June 30, 1960).

39077 Watson, J. F., and Christian, J. L., "Mechanical Properties of High-Strength 301 Stainless Steel Sheet at 70°, -320°, and -423°F in the Base Metal and Welded Joint Configuration", ASTM Special Technical Publication No. 287, 136-149 (June 30, 1960).

39134 Kaufman, J. G., and Johnson, E. W., "New Data on Aluminum Alloys for Cryogenic Applications", Proceedings of the 1960 Cryogenic Engineering Conference, 637-649 (1961).

39412 Christian, J. L., and Watson, J. F., "Mechanical Properties of Inconel X Sheet at 78°, -100°, -320°, and -423°F", Technical Report MRG-150, Convair-Astronautics/General Dynamics (April 20, 1960).

39414 Kropp, C. J., and Foor, E. R., "Mechanical Properties of Heat Treated A-286 Alloy at Various Testing Temperatures, Status Report No. 3", Technical Report MRG-157, Convair-Astronautics/General Dynamics (June 8, 1960).

39429 Watson, J. F., and Christian, J. L., "The Effect of Cryogenic Temperatures on the Mechanical Properties of High Strength Sheet Alloys (Cold Worked Austenitic Stainless Steels)", Technical Report ERR-AN-003, Convair-Astronautics/General Dynamics (May 16, 1960).

39871 Guntner, C. J., and Reed, R. P., "Mechanical Properties of Four Austenitic Stainless Steels at Temperatures Between 300° and 20°K", Proceedings of the 1960 Cryogenic Engineering Conference, 565-576 (1961).

40004 DeSisto, T. S., and Carr, L. C., "Low Temperature Mechanical Properties of 300 Series Stainless Steel and Titanium", Proceedings of the 1960 Cryogenic Engineering Conference, 577-586 (1961).

40128 Christian, J. L., "Mechanical Properties of Titanium and Titanium Alloys at Cryogenic Temperatures", Technical Report MRG-189, Convair-Astronautics/General Dynamics (October 14, 1960).

53299 Tiffany, C. F., Lorenz, P. M., Southworth, H. L., Pall, F. A., Ottlyk, A. A., Fleming, F. C., and Robinson, V. R., "Investigation of Low-Cycle Fatigue Failures Using Applied Fracture Mechanics", Technical Progress Report, Boeing Company, WPAFB Contract AF 33(657)-10251 (October 1963).

53301 Keys, R. D., and Schwartzberg, F. R., "Techniques for Axial Testing of Sheet Materials Down to −423°F", Paper presented at the Sixty-Sixth Meeting of the American Society for Testing and Materials, Atlantic City, New Jersey (June 23-28, 1963).

53308 Schwartzberg, F. R., Keys, R. D., Brown, M. J., and Reightler, C. L., "Determination of Low-Temperature Fatigue Properties of Aluminum and Titanium Alloys", NASA CR-63-29, The Martin Company, Contract NAS 8-2631 (July 1963).

53354 Christian, J. L., and Kerr, J. R., "Selection of Optimum Materials for Use in Liquid-Hydrogen-Fueled Aerospace Vehicles", ASD-TDR-63-798, Astronautics/General Dynamics, WPAFB Contract AF 33(657)-9445 (October 1963).

53548 Morgan, W. R., "Low Temperature Mechanical Properties of A-286 Alloy and Its Weldments", Technical Report IN-P&VE-M-62-4, NASA George C. Marshall Space Flight Center (1962).

53884 DeMoney, F. W., "Performance of a New Cryogenic Aluminum Alloy, 7039", Proceedings of the 1963 Cryogenic Engineering Conference, 112-123 (1964).

53885 Anderson, W. A., Kaufman, J. G., and Kane, J. E., "Notch Sensitivity of Aluminum-Zinc-Magnesium Alloys at Cryogenic Temperatures", Proceedings of the 1963 Cryogenic Engineering Conference, 104-111 (1964).

54661 Kendall, E. G., "Metals and Alloys for Cryogenic Applications — A Review", Technical Report SSD-63-371, Aerospace Corporation, Contract AF 04(695)-269 (January 1964).

54935 Pendleberry, S. L., "Fracture Strength of 6Al-4V-Ti, 5Al-2.5Sn-Ti, and 2014-T6 Al Sheet Containing Shallow Cracks at Room Temperature and −423°F", Transactions of the ASM, 56, 744-752 (1963).

54986 Warren, K. A., and Reed, R. P., "Tensile and Impact Properties of Selected Materials From 20° to 300°K", National Bureau of Standards Monograph 63 (June 28, 1963).

55021 Wroth, R. S., "Effect of Filler Metal Chemistry on the Mechanical Properties of Weldments in 2014-T6 Aluminum", Technical Report SM-43090, Douglas Aircraft Company (1963).

55111 Brisbane, A. W., "The Influence of Loading Rate and Stress Concentration Factors on Notch Properties of Three Sheet Alloys at Room Temperature, −78°C, and −196°C", Proceedings of the 1962 Cryogenic Engineering Conference, 641-653 (1963).

55567 Keys, R. D., and Schwartzberg, F. R., "Axial Fatigue Testing of Sheet Materials Down to −423°F", Materials Research and Standards, 4 (5), 222-224 (May 1964).

55916 Tiffany, C. F., and Lorenz, P. M., "An Investigation of Low-Cycle Fatigue Failures Using Applied Fracture Mechanics", ML-TDR-64-53, The Boeing Company, WPAFB Contract AF 33(657)-10251 (May 1964).

56105 DeSisto, T. S., and Carr, F. L., "The Influence of Subzero Rolling on the Tensile Properties of Commercially Pure Titanium", Technical Report AMRA TR-64-47, Watertown Arsenal (December 1964).

56240 Weiman, S. M., "Cryogenic Properties of Seven Experimental Titanium Alloys", R&D Technical Report SM-44674, Douglas Aircraft Company, Inc. (March 17, 1964).

56261 Christian, J. L., Yang, C. T., and Witzell, W. E., "Physical and Mechanical Properties of Pressure Vessel Material for Application in a Cryogenic Environment", Summary Report GD/A 63-0818-3, Astronautics/General Dynamics, Contract AF 33(657)-11289, Phase II (May 15, 1964).

56510 Anon., "Cryogenic Tensile Properties of Ti-5Al-2.5Sn", Technical Report M-2135, Aerojet-General Corporation (May 14, 1963).

56750 Kiefer, T. F., Keys, D. R., and Schwartzberg, F. R., "Charpy Impact Testing at 20°K", Proceedings of the 1964 Cryogenic Engineering Conference, 56-62 (1965).

56751 Miller, P. C., "Metallurgical Evaluation of a New Aluminum Casting Alloy Developed for Space Vehicle Use at Cryogenic Temperatures", Proceedings of the 1964 Cryogenic Engineering Conference, 37-45 (1965).

56753 Kiefer, T. F., and Keys, R. D., "Fatigue Behavior of Aluminum and Titanium Sheet Materials Down to −423°F", Proceedings of the 1964 Cryogenic Engineering Conference, 1-13 (1965).

56754 Weleff, W., Emmons, W. F., and McQueen, H. S., "Shear Strength of Several Alloys at Liquid-Hydrogen Temperatures", Proceedings of the 1964 Cryogenic Engineering Conference, 50-55 (1965).

56755 Weleff, W., McQueen, H. S., and Emmons, W. F., "Cryogenic Tensile Properties of Selected Aerospace Materials", Proceedings of the 1964 Cryogenic Engineering Conference, 14-25 (1965).

56950 Martin, W. J., Matsuda, T., and Kaluza, E. F., "Study of Titanium Alloy Tankage at Cryogenic Temperatures", Technical Report SM-43116, Douglas Aircraft Company (May 1964).

57031 Hulm, J. K., "Fundamentals of Superconductivity", Cryogenic Engineering, Chapter 8, 251-290, John Wiley & Sons, Inc., N. Y. (1963).

57146 Inouye, F. T., "Inconel 718 Mechanical Properties at −423°F", Technical Report 64-132, Aerojet-General Corporation (January 31, 1964).

57334 Bowers, W. D., "Cryogenic Tensile Properties of 18% Ni-Co-Mo Steel", Technical Report M-2132, Aerojet-General Corporation (March 19, 1963).

57461 Alper, R. H., "Development of High Strength Alloys by Cryogenic Stretchforming", Final Report, Part I, Arde-Portland, Inc., Contract NOw 63-0387-c (September 17, 1964).

57525 Campbell, J. E., "Aluminum Alloys for Cryogenic Service", Materials Research & Standards, 4 (10), 540-548 (October 1964).

57635 Orange, T. W., "Tensile Coupon Tests of Cryoformed AISI 301 Stainless-Steel Pressure Vessels at Cryogenic Temperatures", NASA Technical Note NASA TN D-2202 (October 1964).

57829 Christian, J. L., "Effects of Chemistry and Processing on the Mechanical Properties of Engineering Alloys at Cryogenic Temperatures", Metals Engineering Quarterly, 4 (3), 53-63 (August 1964).

57977 Kamm, G. N., and Alers, G. A., "Low-Temperature Elastic Moduli of Aluminum", Journal of Applied Physics, 35 (2), 327-330 (February 1964).

58021 Burdekin, F. M., "The Fracture Strength of Welded 3-1/2% and 9% Nickel Steels at Low Temperature", British Welding Journal, 11, 586-592 (November 1964).

58024 Schwartzberg, F. R., Kiefer, T. F., and Keys, R. D., "Determination of Low-Temperature Fatigue Properties of Structural Metal Alloys", Final Report, The Martin Company, Contract NAS 8-2631 (October 1964).

58060 Martin, H. L., "Effects of Low Temperatures on Structural Metals", Technical Report NASA SP-5012 (December 1964).

58692 Cataldo, C. E., "The Effects of Liquid Hydrogen on Mechanical Properties of Materials", Technical Report DSN-TN3-60, Redstone Arsenal (March 1960).

58761 Eichenberger, T. W., "Mechanical Property and Fracture Toughness Evaluation of 2219-T6E46 for Cryogenic Applications", Final Report D2-81287, Boeing Company, Contract AF 33(615)-1624 (July 16, 1964).

59159 Shannon, J. L., Jr., and Brown, W. F., Jr., "Effects of Several Alloy Production and Fabrication Variables on the Sharp Notch Properties of 5Al-2.5Sn-Ti Sheet at Liquid Hydrogen Temperature", Paper presented at the Annual ASTM Meeting, Atlantic City, N. J. (June 23, 1963).

59345 Girton, L. D., "Evaluation of Sheet Alloy 718 for Formed and Welded Missile Parts", Technical Report GD/A-ERR-AN-656, General Dynamics/Astronautics (December 1964).

59488 Mishler, H. W., "Steels for Piping Systems With Maximum Pressures of 10,000 psi, and Operating Between −150° and +150°F", Technical Report RSIC-327, Battelle Memorial Institute, Contract DA-01-021-AMC-203Z (November 1964).

59758 Hooper, A. F., and Christian, J., "Evaluation of 2017-T4, 2117-T4, and 5056-H32 Aluminum Alloys at Cryogenic Temperatures", Technical Report AR-592-1-375, General Dynamics, Contract AF 33(616)-7984 (March 1963).

59767 Gruner, J. D., "Additional Information Pertaining to the Effects of Chemical Milling on the Mechanical Properties of Cold Rolled Stainless Steel", Technical Report AR 592-1-521, Astronautics/General Dynamics (April 16, 1964).

59901 Gruner, J. D., "The Effects of Chemical Milling and Chemically Milled Steps on the Mechanical Properties of Type 301 EH and Type 310 EH Stainless Steels at Room and Liquid Hydrogen Temperatures", Technical Report AR-592-1-473, Convair/General Dynamics (July 3, 1963).

60521 Denaburg, C. R., "Low Temperature Mechanical Properties of 8Al-1Mo-1V Titanium Alloys and Composite Weldments", Technical Memorandum NASA TM X-53178 (December 11, 1964).

60578 Christian, J. L., Yang, C. T., and Witzell, W. E., "Physical and Mechanical Properties of Pressure Vessel Materials for Application in a Cryogenic Environment. Part III", Technical Report ASD-TDR-62-258-Part 3, General Dynamics, Contract AF 33(657)-11289 (December 1964).

60691 DeSisto, T. S., and Hickey, C. F., Jr., "Low-Temperature Mechanical Properties and Fracture Toughness of Ti-6Al-6V-2Sn", Technical Report AMRA-TR-65-17 (July 1965).

60698 Kula, E. B., and DeSisto, T. S., "Plastic Behavior of Metals at Cryogenic Temperatures", Technical Report AMRA TR -65-32, Watertown Arsenal (December 1965).

61337 Kramer, B. E., "Development of High Strength, Brazed Aluminum Honeycomb Sandwich Composites Adaptable for Both Elevated and Cryogenic Temperature Applications", Summary Annual Report ER-802, Aeronca Manufacturing Corporation, Contract NAS 8-5445 (January 15, 1965).

61543 Anon., "Development of Stress Relief Treatments for High Strength Aluminum Alloys", Quarterly Progress Report No. 6, Manlabs, Inc., Contract NAS 1-1091 (June 1965).

61688 McClaren, S. W., and Foreman, C. R., "Cryogenic Design Data for Materials Subjected to Uniaxial and Multiaxial Stress Field", Technical Report AFML-TR-65-140, Ling-Temco-Vought, Inc., Contract AF 33(615)-1329 (May 1965).

61918 Pierce, W. S., "Strength Comparison of Flawed Single-Layer and Multilayer AISI 301 Stainless-Steel Pressure Vessels at Cryogenic Temperatures", NASA Technical Note NASA TN D-2949, NASA Lewis Research Center (October 1965).

61996 Kiefer, T. F., Keys, R. D., and Schwartzberg, F. R., "Determination of Low-Temperature Fatigue Properties of Structural Metal Alloys", Final Report, The Martin Company, Contract NAS 8-11300 (October 1965).

62084 Hunsicker, H. Y., and Hess, J. H., "New Weldable High-Strength Aluminum Alloys for Cryogenic Service", Proceedings of the 1965 Cryogenic Engineering Conference, 423-435 (1966).

62292 Lorenz, P. M., "Fracture Toughness and Subcritical Flaw Growth Characteristics of Saturn SI-C Tankage Materials", Technical Report D2-22802, Boeing Company, Contract NAS 8-5608 (April 6, 1964).

62491 Kropp, C. J., "Development of a Superior Titanium-Base Alloy for Cryogenic Applications", Fifth Quarterly Progress Report, Convair/General Dynamics (November 1, 1965).

62857 Carman, C. M., Armiento, D. F., and Markus, H., "Plane-Strain Fracture Toughness of High-Strength Aluminum Alloys", Transactions of the ASME, 87 (4), 904-916 (December 1965).

62943 Tryon, R. W., "The Development of a Superior Titanium-Base Alloy for Cryogenic Applications", Technical Report AFML-TR-65-308, Volume I, Convair/General Dynamics, Contract AF 33(615)-1361 (October 1965).

62985 Gain, B. R., "The Effect of Temperature on Cycle Dependent Deformation", Technical Report AFML-TR-65-288, University of Illinois, Contract AF 33(657)-10822 (August 1965).

63088 Orange, T. W., "Effect of Cold Reduction and Thermal Treatment on Tensile Properties of a Nickel-2 Percent Beryllium Alloy at Cryogenic Temperatures", NASA Technical Note NASA TN D-3196 (January 1966).

63160 Martin, H. L., and Imgram, A. G., "Effects of Low Temperature on Structural Metals", Journal of Metals, 17 (7), 735-741 (July 1965).

63362 Nelson, F. G., Kaufman, J. G., and Holt, M., "Fracture Characteristics of Welds in Aluminum Alloys", Metals Engineering Quarterly, 6 (1), 48-55 (February 1966).

63649 Betts, R. D., "Weld Efficiencies for Inconel 718 TIG Welds. Weld Efficiencies of Inconel 718 Gas Tungsten Arc Welds in the –423° to 1500°F Temperature Range", Final Report MPR-5-175-363, North American Aviation, Inc. (July 27, 1965).

63743 Anon., "Low Temperature Properties of a Large Inconel 718 Forging for Two Heat Treated Conditions", Technical Report MPR-5-175-08, Rocketdyne/North American Aviation (January 7, 1965).

63857 Anon., "Low Temperature and Cryogenic Steels", Trade Literature, United States Steel (March 1966).

64335 Anon., "Armco 21-6-9 Stainless Steel", Product Data Bulletin S-10A, Armco Steel Corporation (1964).

64353 Weiss, V., and Roy, A., "Further Material Evaluation for Supersonic Transport Aircraft", Final Report, S.U.R.I. Report MET. E. 873-6312-F, Syracuse University Research Institute, Contract NASr-43 (December 1963).

64373 Schwanbeck, C. A., "Effect of Nuclear Radiation on Materials at Cryogenic Temperatures", Final Report, NASA CR-54881, Lockheed-Georgia Company, Contracts NAS 3-7987 and NASw-114 (January 1965).

64658 Denaburg, C. R., "Low Temperature Mechanical Properties of Aluminum Alloy 2219-T87, 0.040-Inch Thick Sheet Through 5.000-Inch Thick Plate", NASA TM X-53332 (September 14, 1965).

64728 Morgan, W. R., "Low Temperature Mechanical Properties of HP 9-4-25 Alloy", Technical Memorandum NASA TM X-53302 (July 23, 1965).

64796 Morris, E. E., Darms, F. J., and Landes, R. E., "Low-Cycle, High-Strain Fatigue Resistance of Candidate Materials – Appendix C", Topical Report NASA CR-54855, Aerojet-General Corporation, Contract NAS 3-6292 (April 1966).

64969 Carman, C. M., Forney, J. W., and Katlin, J. M., "Plane Strain Fracture Toughness and Mechanical Properties of 5Al-2.5Sn ELI Titanium at Room and Cryogenic Temperatures", Final Report, NASA CR-54296, Frankford Arsenal, NASA Purchase Order C6860A (April 1966).

65112 Inouye, F. T., "Properties of Large 7079 Aluminum Alloy Forgings in a Cryogenic Environment", Technical Report NASA-CR-513, Aerojet-General Corporation, Contract NAS 3-2555 (July 1966).

65177 Christian, J. L., "Mechanical Properties of Several Nickel-Base Alloys at Room and Cryogenic Temperatures", Proceedings of the 1966 Cryogenic Engineering Conference, 520-530 (1967).

65179 Peterson, N. M., "A Statistical Analysis of Aluminum Welds Tested at Cryogenic Temperatures", Proceedings of the 1966 Cryogenic Engineering Conference, 496-499 (1967).

65180 Corn, D. L., "Cryogenic Properties of 18Ni-9Co-5Mo and 18Ni-7Co-5Mo Maraging Steel Sheet", Proceedings of the 1966 Cryogenic Engineering Conference, 532-543 (1967).

65181 Coursen, J. W., Kaufman, J. G., and Sicha, W. E., "Notch Toughness of Some Aluminum Alloy Castings at Cryogenic Temperatures", Proceedings of the 1966 Cryogenic Engineering Conference, 473-483 (1967).

65182 Weleff, W., "Radiation Effects on Shear Strength of Several Alloys at Liquid Hydrogen Environment", Proceedings of the 1966 Cryogenic Engineering Conference, 544-556 (1967).

65183 Schwartzberg, F. R., "A Review of Cryogenic Fracture Toughness Behavior", Proceedings of the 1966 Cryogenic Engineering Conference, 458-472 (1967).

65184 Eiselstein, H. L., "An Age-Hardenable, Low-Expansion Alloy for Cryogenic Service", Proceedings of the 1966 Cryogenic Engineering Conference, 508-519 (1967).

65692 Bukh, A., "Band of the Boundary of Fatigue With Other Mechanical Properties on Metal", Translation of Mashinostroenie (4), 20-23 (1964).

65778 Montano, J. W., "Low Temperature Mechanical Properties of High Strength A-286 Bolts", Technical Memorandum NASA TM X-53407 (March 9, 1966).

66001 Witherell, C. E., "Welding Nickel-Iron Alloys of the Invar Type", Welding Journal, Welding Research Supplement, 43, 161s-169s (April 1964).

66080 Stinnett, W. D., "Cryogenic Tensile Properties of Selected Materials", Research Report 2712, NASA CR-71751, Aerojet-General Corporation, AEC-NASA Contract SNP-1 (January 1, 1946).

66103 Ferguson, C. W., "Hypervelocity Impact Effects on Liquid Hydrogen Tanks", Final Report, NASA CR-54852, Douglas Missile & Space Systems, Contract NAS 3-4193 (March 31, 1966).

66167 Carman, C. M., Forney, J. W., and Katlin, J. M., "Plane Strain Fracture Toughness of 2219-T87 Aluminum Alloy at Room and Cryogenic Temperatures", Technical Report R-1821, NASA CR-54297, Frankford Arsenal, NASA Purchase Order C6860A (August 1966).

66218 Tiffany, C. F., Lorenz, P. M., and Hall, L. R., "Investigation of Plane-Strain Flaw Growth in Thick-Walled Tanks", Final Report, NASA CR-54837, Boeing Company, Contract NAS 3-4194 (February 1966).

66577 Tilley, E. B., "Evaluation of Inconel 718 Alloy", Technical Report RDR 1181-2, International Harvester Company (June 1, 1965).

66886 Kropp, C. J., "The Development of a Superior Titanium-Base Alloy for Cryogenic Applications", Technical Report AFML-TR-65-308, Volume II, Convair/General Dynamics, Contract AF 33(615)-1361 (September 1966).

67290 Christian, J., "Mechanical Properties of Hastelloy Sheet Alloy R-235 at Cryogenic Temperatures", Technical Report MRG-300, NASA CR-54598, Convair/General Dynamics (March 19, 1962).

67303 Gill, R. S., "Comparative Tensile and Fatigue Properties at Room Temperature and at $-423^{\circ}F$ of Some Welded Centaur Tank Joint Configurations", Technical Report NASA CR-54689, General Dynamics, Contract NAS 3-3232 (October 11, 1963).

67392 Runsicker, H. Y., and Hess, J. H., "New Weldable High Strength Aluminum Alloys for Cryogenic Service", Technical Report NASA CR-71534, Aluminum Corporation of America, Contract NAS 8-5452 (1966).

67747 Christian, J. L., Gruner, J. D., and Girton, L. D., "The Effects of Cold Rolling on the Mechanical Properties of Type 310 Stainless Steel at Room and Cryogenic Temperatures", Technical Report AR-592-1-365, NASA CR-54614, Astronautics/General Dynamics (November 27, 1962).

67749 Iannelli, A. A., and Rizzitano, F. J., "Notched Properties of High-Strength Alloys at Various Load Rates and Temperatures", Technical Report AMRA TR-66-13, Army Materials Research Agency (July 1966).

67769 Robinson, I. B., and Baysinger, F. R., "Welding Aluminum Alloy 7039", Welding Journal Research Supplement, 45, 433-s through 444-s (October 1966).

67891 Christian, J. L., "Problems, Properties and Selection of Structural Metals for Use in Cryogenic Environment", Technical Report W 7-6.1 presented at the 1967 Westec Conference (March 13-17, 1967).

68067 Kramer, B. E., and Potter, D. Y., "Development of High Strength, Brazed Aluminum, Honeycomb Sandwich Composites Adaptable for Both Elevated and Cryogenic Temperature Applications. Volume II – Manufacturing and Testing", Final Report ER-986, Aeronca, Inc., Contract NAS 8-5445 (September 30, 1966).

68621 Westerlund, R. W., and Rogers, R. W., Jr., "Development of a High Strength Aluminum Alloy, Readily Weldable in Plate Thicknesses, and Suitable for Application at $-423^{\circ}F$ ($-253^{\circ}C$)", Annual Report, Aluminum Company of America, Contract NAS 8-5452 (April 1967).

68968 Sullivan, T. L., "Uniaxial and Biaxial Fracture Toughness of Extra-Low-Interstitial 5Al-2.5Sn Titanium Alloy Sheet at $20^{\circ}K$", NASA Technical Note NASA TN-D-4016 (June 1967).

69021 Inouye, F. T., Hunt, V., Janser, G. R., and Frick, V., "Application of Alloy 718 in M-1 Engine Components", Technical Report NASA CR-788, Aerojet-General Corporation, Contract NAS 3-2555 (June 1967).

69310 Beck, E. J., and Mallon, J. A., "Common Bulkhead Joint Developments and Evaluation", Final Report, NASA CR-66-47, The Martin Company, Contract NAS 8-20125 (July 1966).

69332 Horton, J. C., Smith, C. F., and Ruff, R. C., "Low Temperature Thermal Expansion of Structural Metals", Technical Memorandum NASA TM X-53436 (April 18, 1966).

69563 Crane, C. H., Torgerson, R. T., Lovell, D. T., and Baginski, W. A., "Study of Dissimilar Metal Joining by Solid State Welding", Final Report, NASA CR-82460, Boeing Company, Contract NAS 8-20156 (October 1, 1966).

69759 Eitman, D. A., and Rawe, R. A., "Plane Stress Cyclic Flaw Growth of 2219-T87 Aluminum and 5Al-2.5Sn ELI Titanium Alloys at Room and Crogenic Temperatures", Final Report, NASA CR-54956, Douglas Aircraft Company, Contract NAS 3-4192 (September 1, 1966).

69800 McClaren, S. W., Foreman, C. R., and Grabinski, J. F., "Biaxial Strength Characteristics of Selected Alloys in a Cryogenic Environment", Final Report 2-53420/6R-2279, NASA CR-65412, LTV Aerospace Corporation, Contract NAS 9-3873 (May 6, 1966).

70525 Janser, G. R., "Summary of Materials Technology of M-1 Engine", Technical Report AGC 8800-64, NASA CR-54961, Aerojet-General Corporation, Contract NAS 3-2555 (July 22, 1966).

70906 Nachtigall, A. J., Klima, S. J., and Freche, J. C., "Fatigue of Liquid Rocket Engine Metals at Cryogenic Temperatures to −425°F (4°K)", NASA Technical Note NASA TN D-4274 (December 1967).

71237 Malin, C. O., "Low Temperature Properties of Selected Cast and Wrought Aerospace Alloys", Materials and Processes Technical Report MPTR 6-176A-8, Rocketdyne/North American (1968).

71535 Jones, R. L., and Conrad, H., "The Effect of Temperature on the Yield Stress of Commercial Purity Alpha-Titanium", Acta Metallurgica, 15, 649-650 (April 1967).

72427 Wigley, D. A., "Mechanical Properties of Materials at Low Temperatures", Cryogenics, 8 (1), 3-12 (February 1968).

72563 Kaufman, J. G., Bagardus, K. O., and Wanderer, E. T., "Tensile Properties and Notch Toughness of Aluminum Alloys at −452°F in Liquid Helium", Proceedings of the 1967 Cryogenic Engineering Conference, 294-308 (1968).

72742 Anon., "Mechanical and Physical Properties of the Austenitic Chromium-Nickel Stainless Steels at Subzero Temperatures", Trade Literature, The International Nickel Company, Inc. (July 1968).

73817 Anon., "The Behavior of Structural Materials at Extremely Low Temperatures", Technical Report, Rocket Propulsion Establishment (1968).

73890 Smith, G. W., "Centaur Biaxial Fatigue Tests – Model 55", Technical Report AE62-0866, Astronautics/General Dynamics, Contract AF 18(600)-1775 (October 15, 1962).

74405 Clark, A. F., "Low Temperature Thermal Expansion of Some Metallic Alloys", Cryogenics, 8 (5), 282-289 (October 1968).

74862 Zoller, P., Decker, P. R., and Dillinger, J. R., "Anomalous Low-Temperature Specific Heat of Austenitic Stainless Steels", Journal of Applied Physics, 40 (4), 1964-1966 (March 15, 1969).

75385 Pittinato, G. F., "The Reactivity of Hydrogen With Ti-6Al-4V Under Fatigue Cycling at Ambient and Cryogenic Temperatures", Transactions of the ASM Quarterly, 62 (2), 410-417 (June 1969).

75531 Hall, L. R., "Plane-Strain Cyclic Flaw Growth in 2014-T62 Aluminum and 6Al-4V (ELI) Titanium", NASA CR-72396, Boeing Company, Contract NAS 3-7993 (November 1968).

76411 Wessel, E. T., Clark, W. G., and Wilson, W. K., "Engineering Methods for the Design and Selection of Materials Against Fracture", Final Technical Report, Westinghouse Research Laboratories (June 24, 1966).

76455 Pyle, R., Schillinger, D. E., and Carman, C. M., "Plane Strain Fracture Toughness and Mechanical Properties of 2219-T87 Aluminum and 5Al-2.5Sn (ELI) Titanium Alloy Weldments and One-Inch Thick 5Al-2.5Sn (ELI) Titanium Alloy Plate", FA Report R 1897, NASA CR-72154, Frankford Arsenal (September 1968).

76657 Koshelev, P. F., Ilina, R. I., and Nikitina, M. F., "Mechanical Properties of Aluminum Alloys at Low Temperatures", Translation of Mashinostroenie (USSR), (6), 86-94 (1968).

76974 Susukida, H., Ando, T., and Tsuji, I., "Characteristics of 9% Nickel Steel for Low Temperature Service", Technical Report No. MTB010053, Mitsubishi Heavy Industries Ltd. (October 1967).

77044 Hust, J. G., and Powell, R. L., "Thermal Conductivity of Aerospace Alloys at Cryogenic Temperatures", Proceedings of the 8th Conference on Thermal Conductivity, Purdue University (October 7-10, 1968).

77185 Frederick, S. F., and Hanna, W. D., "Fracture Toughness and Deformation of Titanium Alloys at Low Temperatures", Metallurgical Transactions, 1 (2), 347-352 (February 1970).

77737 McLean, K. O., "Low Temperature Thermal Expansion of Copper, Silver, Gold, and Aluminum", Ph.D. Dissertation, Iowa State University (November 1969).

77930 Nachtigall, A. J., "Comparison of Tensile Properties of 304L and 310S Stainless Steels in Liquid Helium", NASA Technical Memorandum NASA TM X-52703 (October 30, 1969).

77998 Shogan, R. P., "Tensile Properties of Irradiated Ti-5%Al-2.5%Sn ELI at Cryogenic Temperatures", Technical Report WANL-TME-1860, Westinghouse Electric Company (November 1968).

78025 Rapp, O., "Superconductivity and Lattice Parameters in the Zirconium-Molybdenum, Zirconium-Tungsten, Hafnium-Molybdenum and Hafnium-Tungsten Alloy Systems", Journal of the Less-Common Metals, 21 (1), 27-44 (May 1970).

78527 Roberts, B. W., "Superconductive Materials and Some of Their Properties", NBS Technical Note 482 (May 1969).

78611 Pettit, D. E., Feddersen, C. E., and Mindlin, H., "Flaw Growth Behavior of Inconel 718 at Room and Cryogenic Temperatures", NASA CR-101942, Final Report, Battelle Memorial Institute, Contract NAS 9-7689 (March 1970).

78652 Younger, C. L., and Haley, F. A., "Irradiation Effect at Cryogenic Temperature on Tensile Properties of Titanium and Titanium-Base Alloys", Technical Memorandum NASA TM X-52772 (1970).

78884 Hempel, M., "The Fatigue Properties of Titanium and Titanium Alloys. Part I. The Fatigue Strength at Low and High Temperatures", Technical Report RAE-Library Trans-1400, TRC-BR-18776, Royal Aircraft Establishment (January 1970).

78893 Hafstrom, J. W., and MacVicar, M.L.A., "The Second Energy Gap in Superconducting Niobium", Technical Report No. 3, MIT, Contract N00014-67-A-0204-0041 (September 24, 1970).

79301 Rawe, R. A., "Biaxial Strength of MIG- and TIG-Welded 2014-T6 at 70°, –320° and –423°F", Technical Report NASA CR-109904, Douglas Aircraft Company, Contract NAS 7-101 (May 24, 1968).

79385 Moskalenko, V. A., Puptsova, V. N., and Ul'yanov, R. A., "Strength and Ductility of Titanium Alloys at Low Temperatures", Metal Science and Heat Treatment, (6), 464-466 (June 1970).

79425 Clark, A. F., Childs, G. E., and Wallace, G. H., "Low-Temperature Electrical Resistivity of Some Engineering Alloys", Proceedings of the 1969 Cryogenic Engineering Conference, 85-90 (1970).

79561 Clark, A. F., Childs, G. E., and Wallace, G. H., "Electrical Resistivity of Some Engineering Alloys at Low Temperatures", Cryogenics, 10 (4), 295-305 (August 1970).

79761 Schultz, R. A., "ALCOA Aluminum Alloy 2021", Manufacturers' Literature, Aluminum Company of America (April 1968).

79816 Hall, L. R., and Finger, R. W., "Fracture and Fatigue Growth of Partially Embedded Flaws", Proceedings of the Air Force Conference on Fatigue and Fracture of Aircraft Structures and Materials, 235-262 (December 1969).

79857 Tiffany, C. F., Masters, J. N., and Bixler, W. D., "Investigation of Crack Growth Threshold of Inconel 718 Exposed to High Pressure Oxygen", Technical Report NASA CR-108485, Boeing Company, Contract NAS 9-10913 (August 1970).

79942 Buchanan, D. P., and Kellum, T. L., "Weldability Study of Aluminum Alloy X2020-T8E31", Technical Report ASD-ASTN-1273, Teledyne Brown Engineering Company, Contract NAS 8-20073 (February 1971).

80073 Schwartzberg, F. R., Keys, R. D., and Kiefer, T. F., "Cryogenic Alloy Screening", Final Report, NASA CR-72733, The Martin Company, Contract NAS 3-11203 (November 1970).

80104 Orange, T. W., Sullivan, T. L., and Calfo, F. D., "Fracture of Thin Sections Containing Through and Part-Through Cracks", ASTM Special Technical Publication 496 (August 1971).

80473 Hill, D. C., and Rose, R. M., "Superconductivity and Dislocation Cell Structure in Niobium: Stress Effects", Metallurgical Transactions, 2 (5), 1433-1437 (May 1971).

80755 Montano, J. W., "An Evaluation of the Mechanical and Stress Corrosion Properties of Cold Worked A-286 Alloy", NASA Technical Memorandum NASA TM X-64569 (February 12, 1971).

80804 Hust, J. G., and Clark, A. F., "The Lorenz Ratio as a Tool for Predicting the Thermal Conductivity of Metals and Alloys", Materials Research and Standards, 11 (8), 22-24 (August 1971).

80873 Herzog, R. G., Osgood, S. H., and Lighty, D., "Properties of Cryogenically-Worked Materials", Cryogenics & Industrial Gases, 7 (6), 25-29 (November/December 1972).

80994 Vishnevsky, C., and Steigerwald, E. A., "Plane Strain Fracture Toughness of Some Cryogenic Materials at Room and Subzero Temperatures", ASTM Special Technical Publication 496 (August 1971).

80995 Nelson, F. G., and Kaufman, J. G., "Plane Strain Fracture Toughness of Aluminum Alloys at Room and Subzero Temperatures", ASTM Special Technical Publication 496 (August 1971).

80996 Hall, L. R., "Influence of Specimen Design in Plane Strain Fracture Toughness Testing", ASTM Special Technical Publication 496 (August 1971).

81676 Grigsby, D. L., "Niobium Alloys and Compounds", Data Sheet Report DS-148, Hughes Aircraft, Contract AF 33(615)-2460 (January 28, 1966).

81726 Sullivan, T. L., "Behavior of Ti-5Al-2.5Sn ELI Titanium Alloy Sheet Parent and Weld Metal in the Presence of Cracks at 20°K", NASA Technical Note NASA TN D-6544 (November 1971).

82075 Clark, A. F., and Kropschot, R. H., "Low Temperature Specific Heat and Thermal Expansion of Alloys", Proc. Comm. 1, Conf. on Cryophysics and Cyroengineering, Tokyo, Japan (September 11-12, 1970).

82097 Hust, J. G., and Sparks, L. L., "Thermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys From 4° to 300°K: III. Annealed Inconel 718", NBS Technical Report 9775 (November 24, 1970).

82489 Fickett, F. R., "Magnetoresistance of Very Pure Polycrystalline Aluminum", Physical Review B, 3 (6), 1941-1952 (March 15, 1971).

82534 Larbalestier, D. C., and King, H. W., "Non Magnetic Stainless Steels for Cryogenic Purposes", Technical Report RHEL/R 217, Imperial College, London (January 1971).

82916 Schwartzberg, F. R., Keys, R. D., and Kiefer, T. F., "Cryogenic Alloy Screening", Interim Report NASA CR-72617, Martin Marietta Corporation, Contract NAS 3-11203 (February 1970).

82964 Malin, C. O., "Low-Temperature Properties of Free-Machining 300-Series CRES", Reportable Item Submission Number MFS-18241, Rocketdyne/North American, Contract NASw-16 (June 14, 1968).

82965 Malin, C. O., "Low-Temperature Properties of Cast Inconel 718", Reportable Item Submission Number MFS-18240, Rocketdyne/North American, Contract NASw-16 (June 14, 1968).

82966 Malin, C. O., "Low-Temperature Properties of Large Inconel 718 Forgings", Reportable Item Submission Number MFS-18244, Rocketdyne/North American, Contract NASw-16 (June 14, 1968).

82968 Malin, C. O., "Low-Temperature Properties of Cast 310 and 347 CRES", Reportable Item Submission Number MFS-18235, Rocketdyne/North American, Contract NASw-16 (June 21, 1968).

83069 Chandrasekaran, V., Narasimhan, S., and Werstler, D., "A Study of Phase Transformations and Superconductivity", Annual Progress Report RLO-2225-T13-9, University of Washington, Contract AT(45-1)-2225 (October 15, 1971).

83089 Halchak, J. A., "Low-Temperature Properties of Forgings of Titanium 5Al-2.5Sn Alloy (ELI)", Reportable Item Submission Number MFS-18245, Rocketdyne/North American, Contract NASw-16 (June 21, 1968).

83166 Malin, C. O., "Low-Temperature Properties of Armco 21-6-9 Alloy (Cr-Ni-Mn)", Reportable Item Submission Number MFS-18243, Rocketdyne/North American (June 14, 1968).

83168 Green, E. F., "Low-Temperature Properties of 9-Percent Nickel, 4-Percent Cobalt (HP9-4-25) High-Strength Steel Forged Block and Plate", Reportable Item Submission Number MFS-18282, Rocketdyne/North American, Contract NASw-16 (July 5, 1968).

83169 Green, E. F., "Low-Temperature Properties of 18-Percent Nickel (200-Grade) Maraging Steel Plate", Reportable Item Submission Number MFS-18281, Rocketdyne/North American, Contract NASw-16 (July 3, 1968).

83171 Malin, C. O., "Low-Temperature Properties of Cast A-286", Reportable Item Submission Number MFS-18237, Rocketdyne/North American (June 14, 1968).

83411 Romig, H. L., "Guaranteed Minimum Mechanical Properties, Type 310 Stainless Steel Welded With Inconel 92 (Incoweld A) Filler Alloy, at Cryogenic Temperatures", Materials and Processes Report MPR 7-176A-101, Rocketdyne/North American (June 13, 1967).

83417 Schmidt, E. H., "Fatigue Properties of Sheet, Bar, and Cast Metallic Materials for Cryogenic Applications", Technical Report R-7564, Rocketdyne/North American, Contract NAS 8-18734 (August 30, 1968).

83474 Vozilkin, V. A., Buynov, N. N., and Bychkov, Y. F., "The Electron Microscopic Study of the Structure of the Superconducting Alloy Ti-22Nb", The Physics of Metals and Metallography, 30 (4), 82-90 (1970).

83773 Huettich, N. J., Pense, A. W., and Stout, R. D., "The Toughness of 2-1/4% and 3-1/2% Nickel Steels", WRC (Welding Research Council) Bulletin 165 (September 1971).

83803 Hartbower, C. E., Reuter, W. G., and Morais, C. F., "Correlation of Stress-Wave-Emission Characteristics With Fracture in Aluminum Alloys", Technical Report NASA CR-2072, Aerojet Solid Propulsion Company, Contract NAS 8-21405 (July 1972).

83948 Montano, J. W., "The Effects of Solution Treatment on the Mechanical Properties of Age-Hardened A-286 Bar Stock at Elevated and Cryogenic Temperature", NASA Technical Memorandum NASA TM X-64638 (February 16, 1972).

84014 Tom, T., "Application of Powder Metallurgy Process in the Formation of Nb(sub 3)Al Superconductor", Summary Report LBL-188, University of California, Contract W-7405-Eng-48 (December 1971).

84318 Masters, J. N., Haese, W. P., and Finger, R. W., "Investigation of Deep Flaws in Thin Walled Tanks", Final Report D2-121696-1, NASA CR-72606, Boeing Company, Contract NAS 3-10290 (December 1969).

84319 Engstrom, W. L., "Determination of Design Allowable Properties – Fracture of 2219-T87 Aluminum Alloy", Technical Report D180-14480-1, NASA CR-115388, Boeing Company, Contract NAS 9-10364 (March 1972).

84320 Tiffany, C. F., Lorenz, P. M., and Shah, R. C., "Extended Loading of Cryogenic Tanks", Final Report, NASA CR-72252, Boeing Company, Contract NAS 3-6290 (July 1967).

84321 Hall, L. R., and Finger, R. W., "Investigation of Flaw Geometry and Loading Effects on Plane Strain Fracture in Metallic Structures", Final Report, NASA CR-72659, Boeing Company, Contract NAS 3-12016 (December 18, 1971).

84346 Feddersen, C. E., "Fracture Behavior of Surface-Cracked Tension Elements", AIAA Journal, 9 (12), 2309-2313 (December 1971).

84348 Shoemaker, A. K., and Rolfe, S. T., "The Static and Dynamic Low-Temperature Crack-Toughness Performance of Seven Structural Steels", Engineering Fracture Mechanics, 2, 319-339 (1971).

84503 Luhman, T. S., Taggart, R., and Polonis, D. H., "Magnetic Hysteresis Studies of Superconducting Beta Stabilized Titanium Alloys", Scripta Metallurgica, 6 (11), 1055-1060 (November 1972).

84527 Midgley, P., Thackray, R. W., and Herrick, D.A.R., "The Effect of Heat Treatment and Fabrication Processes on the Tensile Properties of the Aluminum Alloy Hiduminium 48 in the Temperature Range 293°K to 20°K", Technical Report 70/10, Rocket Propulsion Establishment (October 1970).

84743 Collings, B. W., and Grog, K. C., "Electronic Effects Due to Micro-Inhomogeneities in Metastable Solid Solution Alloys", Interim Report AFOSR-TR-72-1279, Battelle Memorial Institute, Research Grant AFOSR-71-2084 (June 23, 1972).

85056 Sekula, S. T., and Kernohan, R. H., "AC Studies of a Superconducting Nb-52Ti Alloy", Summary Report, CONF-720513-4, Union Carbide (April 1972).

85296 Hust, J. G., and Sparks, L. L., "Thermal Conductivity of Austenitic Stainless Steel, SRM 735, From 5 to 280 K", Summary Report, NBS-SP-260-35, NBS (April 1972).

85332 Finlayson, T. R., and Milne, I., "The Critical Current Density of Deformed and Annealed Superconducting Nb-26% Zr and Nb-32% Zr and Its Dependence on the Amount of Deformation", Journal of Materials Science, 7 (12), 1391-1400 (December 1972).

85568 Westrup, R. W., "Establishment of Design Criteria for Acceptable Failure Modes and Fail Safe Considerations for the Space Shuttle Structural System", Final Report SD72-SH-0046, NASA CR-123725, North American, Contract NAS 8-27269 (June 1, 1972).

85738 Somasundaram, R., and Toth, L. R., "Studies of Superconducting Thin Film Carbides and Nitrides", Final Report, University of Minnesota, Contract DAAK02-70-C-0181 (July 1971).

85780 Schlosser, S., Johnson, A. A., and Mukherjee, K., "The Low Temperature Tensile Properties of Surface Oxidized Polycrystalline Molybdenum", Materials Science and Engineering, 11 (2), 81-86 (February 1973).

85820 Janocko, M. A., Jones, C. K., and Gavaler, J. R., "Investigations of Superconducting Interactions and Amorphous Semiconductors", Final Report, NASA CR-129524, Westinghouse Electric Corporation, Contract NASw-1760 (October 1972).

85971 Laurence, J., Worzala, F. J., and Yang, W. J., "Fabrication Studies of Nb(Sub 3)Al Superconductors", Paper presented at the Fourth International Cryogenic Engineering Conference, Eindhoven, Netherlands (May 24-26, 1972).

86296 Hall, L. R., and Bixler, W. D., "Subcritical Crack Growth of Selected Aerospace Pressure Vessel Materials", Technical Report D180-14855-1, NASA CR-120834, Boeing Company, Contract NAS 3-12044 (December 1972).

86678 Ho, C. Y., "Thermophysical Properties Information Analysis Center: A Continuing Systematic Program on Tables of Thermophysical Properties of Materials", Final Report AMMRC CTR-73-5, Purdue University, Contract F33615-71-C-1182 (January 1973).

86726 Krainskii, I. S., and Shchegolev, I. F., "Properties of Welded Joints Between Wires of Nb-Zr-Ti and Nb + Ti Alloys", Cryogenics, 13 (2), 106-107 (February 1973).

87195 Hall, L. R., and Finger, R. W., "Stress Corrosion Cracking and Fatigue Crack Growth Studies Pertinent to Spacecraft and Booster Pressure Vessels", Technical Report D180-15018-1, NASA CR-120823, Boeing Company, Contract NAS 3-12003 (December 1972).

87223 Hall, L. R., and Finger, R. W., "Fracture and Crack Growth Resistance Studies of 304 Stainless Steel Weldments Relating to Retesting of Cryogenic Vessels", Final Report, NASA CR-121025, Boeing Company, Contract NAS 3-12003 (December 1972).

87328 Gille, J. P., "Development of Advanced Material Composites for Use as Internal Insulation for LH_2 Tanks (Gas Layer Concept)", Final Report, MCR-72-130, NASA CR-124222, Martin Marietta Corporation, Contract NAS 8-25974 (July 1972).

87479 Gasanov, M. A., Romashev, L. N., and Fakidov, I. G., "Magnetic Properties of Stainless Steel Kh18N10T", The Physics of Metals and Metallography, 33 (2), 190-191 (1972).

87575 Witcomb, M. J., and Dew-Hughes, D., "Superconductivity of Heat-Treated Nb-65 at.% Ti Alloy", Journal of Materials Science, 8 (10), 1383-1400 (October 1973).

87612 Bixler, W. D., "Development of a Fracture Control Method for Composite Tanks With Load Sharing Liners", Final Report D180-15296-1, NASA CR-120918, Boeing Company, Contract NAS 3-14380 (March 1973).

87734 Okazaki, K., and Conrad, H., "Effects of Interstitial Content and Grain Size on the Strength of Titanium at Low Temperature", Acta Metallurgica, 21, 1117-1129 (August 1973).

87736 Stutius, W., and Dillinger, J. R., "Magnetic and Thermal Properties of Some Austenitic Stainless Steels at Low Temperatures", Journal of Applied Physics, 44 (6), 2887-2888 (June 1973).

87777 Garde, A. M., Aigeltinger, E., and Reed-Hill, R. E., "Relationship Between Deformation Twinning and the Stress-Strain Behavior of Polycrystalline Titanium and Zirconium at 77°K", Metallurgical Transactions, 4 (10), 2461-2468 (October 1973).

87816 Anon., "New Ni-Fe-Co Alloy Combats Stresses", Metal Progress, 104 (5), 7 (October 1973).

88109 Forman, R. G., Glorioso, S. V., and Medlock, J. D., "Flaw Growth Behavior in Thick Welded Plates of 2219-T87 Aluminum at Room and Cryogenic Temperatures", NASA Technical Note NASA-TN-D-7377 (August 1973).

88112 Sarno, D. A., McCabe, D. E., Sr., and Heberling, T. G., "Fatigue and Fracture Toughness Properties of 9 Percent Nickel Steel at LNG Temperatures", Transactions of the ASME, Series B, Journal of Engineering for Industry, 95 (4), 1069-1075 (November 1973).

88248 Wolff, E. G., Lepper, R., and Mills, G. J., "Relationships Between Microstructure, Superconductivity and Mechanical Properties of Ti-6Al-4V", Titanium Science and Technology, Volume II, 843-858, Plenum Press, N. Y. (1973).

88439 Reuter, W. G., "Fracture Toughness of Ti-5Al-2.5Sn ELI Forgings at -423°F", Memoranda and Material R&D Report, Aerojet-General Corporation (January 26, 1971).

88757 McCracken, G. M., and Blow, S., "The Shielding of Superconducting Magnets in a Fusion Reactor", Summary Report, CLM-R-120, Culham Laboratory, UKAEA Research Group (1972).

88966 Tharby, R. H., Heath, D. J., and Flannery, J. W., "The Welding of 9 Percent Nickel Steel — A Review of the Current Practices", Paper presented at the Welding Institute's International Conference, Welding Low Temperature Containment Plant, London, England (November 20-22, 1973).

89523 Madhava, N. M., and Armstrong, R. W., "Discontinuous Twinning of Titanium at 4.2°K", Metallurgical Transactions, 5 (6), 1517-1519 (June 1974).

89525 Naimon, E. R., Weston, W. F., and Ledbetter, H. M., "Elastic Properties of Two Titanium Alloys at Low Temperatures", Cryogenics, 14 (5), 246-249 (May 1974).

89543 Nachtigall, A. J., "Strain-Cycling Fatigue Behavior of Ten Structural Metals Tested in Liquid Helium (4°K), in Liquid Nitrogen (78°K), and in Ambient Air (300°K)", NASA Technical Note NASA TN D-7532 (February 1974).

89681 Gulyaev, A. P., Lebedev, D. V., and Gadzhibalaev, G. A., "Strength and Ductility of Austenitic Cr-Ni and Cr-Mn Steels at Low Temperatures", Metal Science and Heat Treatment, 15 (11-12), 1051-1055 (November-December 1973).

89716 Masters, J. N., Bixler, W. D., and Finger, R. W., "Fracture Characteristics of Structural Aerospace Alloys Containing Deep Surface Flaws", Final Report NASA CR-134587, Boeing Aerospace Company, Contract NAS 3-14341 (December 1973).

89747 Gasanov, M. A., and Fakidov, I. G., "Thermal Expansion, Young's Modulus and Magnetostriction of a Stainless Iron-Chromium-Nickel Alloy in the Range $80\text{-}280^{\circ}$K", Physics of Metals and Metallography, 35 (3), 200-202 (1973).

89983 Masters, J. N., Engstrom, W. L., and Bixler, W. D., "Deep Flaws in Weldments of Aluminum and Titanium", Final Report, NASA CR-134649, Boeing Aerospace Company, Contract NAS 3-14386 (April 1974).

90067 Kaufman, J. G., Holt, M., and Wanderer, E. T., "Aluminum Alloys for Cryogenic Temperatures", Paper presented at the Cryogenic Engineering Symposium of the Canadian Chemical Conference, Toronto, Canada (June 7, 1967).

90068 Schwartzberg, F., Agricola, K., and Hauser, R., "Properties of Missile Materials at Cryogenic Temperatures", Technical Report, Martin Company (May 1960).

90069 Kaufman, J. G., Nelson, F. G., and Johnson, E. W., "Properties of Aluminum Alloy 2219 Sheet, Plate, and Welded Joints at Low Temperatures", Proceedings of the 1962 Cryogenic Engineering Conference, 661-670 (1963).

90070 Kaufman, J. G., and Wanderer, E. T., "Tensile Properties and Notch Toughness of Some 7XXX Alloys at –452°F", Proceedings of the 1970 Cryogenic Engineering Conference, 27-36 (1971).

90071 Armstrong, P. E., and Eash, D. T., "Simultaneous Measurement of Young's Modulus and Shear Modulus at Low Temperatures", Proceedings of the 1968 Cryogenic Engineering Conference, 64-70 (1969).

90072 Nelson, F. G., Kaufman, J. G., and Wanderer, E. T., "Tensile Properties and Notch Toughness of Groove Welds in Wrought and Cast Aluminum Alloys at Cryogenic Temperatures", Proceedings of the 1968 Cryogenic Engineering Conference, 71-82 (1969).

90073 Christian, J. L., and Watson, J. F., "Mechanical Properties of Several 2000 and 6000 Series Aluminum Alloys", Proceedings of the 1964 Cryogenic Engineering Conference, 63-76 (1965).

90074 Fox, D. K., and Pryle, W. H., "Test Apparatus and Tensile Properties of Niobium-Zirconium Superconductor Alloy Wire in the Temperature Range 300° to 4.2°K", Proceedings of the 1963 Cryogenic Engineering Conference, 124-130 (1964).

90075 DeMoney, F. W., "Effect of Aging on the Tensile Properties of Alloy 7039 GTA Welds at Low Temperatures", Proceedings of the 1966 Cryogenic Engineering Conference, 500-507 (1967).

90076 Hanson, M. P., Stickley, G. W., and Richards, H. T., "Sharp-Notch Behavior of Some High-Strength Sheet Aluminum Alloys and Welded Joints at 75°, –320°, and –423°F", ASTM Special Technical Publication No. 287 (June 1960).

90077 Lucas, W. R., and Cataldo, C. E., "Some Low-Temperature Properties of Aluminum-Alloy Weldments", ASTM Special Technical Publication No. 287 (June 1960).

90078 Christian, J. L., "Mechanical Properties of Aluminum Alloys at Cryogenic Temperatures", Technical Report MRG-190, Convair-Astronautics/General Dynamics (December 2, 1960).

90079 Watson, J. F., and Christian, J. L., "Low-Temperature Properties of K-Monel, Inconel-X, Rene 41, Haynes 25, and Hastelloy B Sheet Alloys", Paper presented at the Winter Annual Meeting of the American Society of Mechanical Engineers, New York, N. Y. (November 26-December 1, 1961).

90080 DeSisto, T. S., "Low Temperature Charpy True Stress-Strain and Notched Tensile Properties of Base Metal and Weld Deposits of AISI Type 301, 310, 316 and 347 Stainless Steels", Paper presented at the Annual ASTM Meeting, New York (June 1962).

90533 Cordea, J. N., Frisby, D. L., and Kampschaefer, G. E., "5% Nickel: New Steel Seeks LNG Niche", Cryogenics and Industrial Gases, 7 (6), 15-21 (November/December 1972).

90534 Bell, J. H., Jr., "Materials of Construction", Cryogenic Engineering, Chapter 6, 131-167, Prentice-Hall, Inc., New Jersey (1963).

90535 Fluornoy, R. W., "Aluminum Alloys for Cryogenic Equipment", Light Metal Age, 19, 10-12+28 (April 1962).

90536 Anon., "9% Nickel Steel for Low Temperature Service", Manufacturers' Literature 25C 2-60 3749 A-263, International Nickel Company, Inc. (no date given).

90537 Anon., "9% Nickel Steel for Low Temperature Service", Manufacturers Literature, A-263, 5M 10-73 (5C 1-72) 3749, International Nickel Company, Inc. (no date given).

90538 Suenaga, M., and Sampson, W. B., "A Comparative Study of Superconducting Composite Conductors With Filaments of A-15 Compounds", BNL 17222, Brookhaven National Laboratory (received October 9, 1973).

90539 Fuller, P. D., and McLagan, J. N., "Storage and Transfer of Cryogenic Fluids", Applied Cryogenic Engineering, Chapter 9, 249, John Wiley & Sons, Inc., New York (1962).

90540 Buchhold, T. A., "Applications of Superconductivity", Cryogenic Engineering, Chapter 9, 291-310, John Wiley & Sons, Inc., New York (1963).

90624 McDaniel, R. H., Bradford, E. W., Lewis, J. H., and Wattier, J. B., "NERVA Irradiation Program—GTR 23- Volume I—Combined Effects of Reactor Radiation and Cryogenic Temperature on NERVA Structural Materials", NASA CR-137267, General Dynamics Corporation, Contract AF 29(601)-7077 (January, 1973).

90717 Forman, R. G., "Crack-Growth Behavior in Thick Welded Plates of Inconel 718 at Room and Cryogenic Temperatures", NASA Technical Note NASA TN D-7665, Lyndon B. Johnson Space Center (May 1974).

91494 Jin, S., Hwang, S. K., and Morris, J. W., Jr., "Comparative Fracture Toughness Testing of Cryogenic Alloys at Liquid Helium Temperature", Technical Report TR-5, University of California, Contract N00014-69-A-1062 (August 1974).

91696 Shah, R. C., "Effects of Proof Loads and Combined Mode Loadings on Fracture and Flaw Growth Characteristics of Serospace Alloys", NASA CR-134611, Technical Report D 180-17997-1, Boeing Company, Contract NAS 3-14346 (March 1974).

91793 Wan Stone, R. H., Low, J. R., Jr., and Shannon, J. L., Jr., "The Effect of Microstructure on the Fracture Toughness of Titanium Alloys", NASA Technical Report 2-Ti, Carnegie-Mellon University, NASA Research Grant 39-087-047 (December 1974).

91978 Haynes, A. G., Firth, L., Hollox, G. E., and Buchan, J., "Strength and Fracture Toughness of Nickel Containing Steels", ASTM STP 579, 288-323 (1975).

92996 Pense, A. W. and Stout, R. D., "Fracture Toughness and Related Characteristics of the Cryogenic Nickel Steels", WRC Bulletin, No. 205, 1-43 (May, 1975).

93338 Witzell, W. E., "Crack Growth Behavior of 2219-T87 Aluminum Alloy From 20 K (-423 F) to 422 K (300 F)", CASD-NAS-73-011, Nasa CR-134047, General Dynamics, Contract NAS 9-12445 (August 1973).

94195 Fedorov, G. V. and Ryabinina, N. M., "Hall Effect, Magnetic Susceptibility and Resistivity of Cu-Ni Alloys", Physics of Metals and Metallography, 29 (1), 82-86 (1970).

94196 Furukawa, G. T., McCoskey, R. E., and King, G. J., "Calorimetric Properties of Polytetrafluoroethylene(Teflon) From 0° to 365°K", Journal of Research of the National Bureau of Standards, 49 (4), 273-278 (October, 1952).

94197 Jin, S., Morris, J. W., Jr., and Zackay, V. F., "An Iron-Nickel-Titanium Alloy With Outstanding Toughness at Cryogenic Temperatures", Advances in Cryogenic Engineering, 19, 379-384 (1974).

94198 Tucker, J. E., "Heat Capacity on Polyethylene in the Temperature Range of 2.4° to 30°K", Doctorial Thesis, U.S. Naval Postgraduate School (May, 1966).

94199 Warfield, R. W. and Petree, M. C., "Thermodynamic Properties of Polyethylene", Technical Report NOLTR 61-92, U.S. Naval Ordinance Laboratory (October, 1961).

94200 Warfield, R. W. and Petree, M. C., "Thermodynamic Properties of Polystyrene and Styrene", NAVWEPS Report 7352, U.S. Naval Ordinance Laboratory (September 21, 1960).

94201 Warfield, R. W. and Petree, M. C., "Thermodynamic Properties of Polymethyl Methacrylate and Methyl Methacrylate", NOLTR 62-98, U.S. Naval Ordinance Laboratory (January 17, 1962).

94202 Mowers, R. E., "Program of Testing Nonmetallic Materials at Cryogenic Temperatures", Final Report, Technical Documentary Report RTD-TDR-63-11, Rocketdyne/North American Aviation, Incorporated, Contract AF 04(611)-6354 (December 30, 1962).

94203 Wunderlich, B., "Heat Capacities of Linear High Polymers", Technical Report No. 17, Rensselaer Polytechnic Institute, Contract Nonr-591(19) (November, 1968).

94204 Hurlich, A. and Scheck, W. G., "Evaluation and Application of Stainless Steels in Cryogenic Environments", Advances in the Technology of Stainless Steels and Related to Alloys, ASTM Special Technical Pulication No. 369, 127-135 (1963).

94205 Brickner, K. G., "Stainless Steels for Room and Cryogenic Temperatures", Metals Engineering Quarterly, 8 (2), 1-29 (May, 1968).

94206 Clark, A. F., Reed, R. P., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-II", Second Semi-Annual Technical Report, NBS (March 1, 1974—September 1, 1974).

94206A Schwartzberg, F. R., "Study of Fracture Behavior of Metals for Superconducting Applications", Second Annual Technical Report MCR-74-89, Martin Marietta Corporation (October, 1974).

94206B Tobler, R. L., Mikesell, R. P., Durcholz, R. L., and Reed, R. P., "Fatigue and Fracture Toughness Testing at Cryogenic Temperatures", Semi-Annual Report, NBS (October, 1974).

94206C Ledbetter, H. M., Naimon, E. R., and Weston, W. F., "Elastic Properties of Engineering Materials at Cryogenic Temperatures", Semi-Annual Report, NBS (October 1974).

94206D Naimon, E. R., Weston, W. F., and Ledbetter, H. M., "Elastic Properties of Two Titanium Alloys at Low Temperatures", Cryogenics, 14, 246-249 (1974).

94206E Lessmann, G. G., Kossowsky, R., Logsdon, W. A., et al, "Structural Materials For Cryogenic Applications", Second Semi-Annual Technical Report, Westinghouse Electric Corporation (September 9, 1974).

94207 Ledbetter, H. M., Naimon, E. R., and Weston, W. F., "Low-Temperature Elastic Properties of Invar", Paper D-3 presented at the Cryogenic Engineering—International Cryogenics Materials Joint Conference, Queens University, Kingston, Canada (July 22-25, 1975).

94208 Reed, R. P., Clark, A. F., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-III", Third Semi-Annual Technical Report, NBS-ARPA (September 1, 1974—March 1, 1975).

94208A Schwartzberg, F. R. and Kiefer, T., "Study of Fracture Behavior of Metals for Superconducting Applications", Semi-Annual Technical Report, MCR-74-89 (Issue 3), Martin Marietta Corporation (April, 1975).

94208B Fowlkes, C. W. and Tobler, R. L., "Fracture Testing and Results for a Ti-6Al-4V Alloy at Liquid Helium Temperature", Technical Report, NBS (1974).

94208C Tobler, R. L., "Fatigue Crack Growth and J—Integral Fracture Parameters of Ti-6Al-4V at Ambient and Cryogenic Temperatures", Technical Report, NBS (1974).

94208D Tobler, R. L., and Reed, R. P., "Fatigue Crack Growth Rates of Structural Alloys at Four Kelvin", Technical Report, NBS (1974-1975).

94208E Reed, R. P., Tobler, R. L., and Mikesell, R. P., "The Fracture Toughness and Fatigue Crack Growth Rate of an Fe-Ni-Cr Superalloy at 298°, 76° and 4°K", Technical Report, NBS (1974-1975).

94208F Weston, W. F. and Ledbetter, H. M., "Low-Temperature Elastic Properties of a Nickel-Chromium-Iron-Molybdenum Alloy", Technical Report, NBS (1974-1975).

94208G Wells, J. M., Kossowsky, R., Logsdon, W. A., and Daniel, M. R., "Structural Materials for Cryogenic Applications", Third Semi-Annual Technical Report, Westinghouse Electric Corporation (March 10, 1975).

95168 Clark, A. F., Reed, R. P., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-IV", Fourth Semi-Annual Technical Report, National Bureau of Standards (October 1975).

95168A Jelinek, F. J., and Collings, E. W., "Low-Temperature Thermal Expansion and Specific Heat Properties of Structural Materials", Technical Report, Battelle's Columbus Laboratories, Contract CST-8303 (October 20, 1975).

95168B Schwartzberg, F. R., and Kiefer, T., "Study of Fracture Behavior of Metals for Superconducting Applications", MCR-74-89 (Issue 4), Martin Marietta Corporation, Contract CST-830 (November 1975).

95168C Ledbetter, H. M., Naimon, E. R., and Weston, W. F., "Elastic Properties of Engineering Materials at Cryogenic Temperatures", Technical Report, NBS (October 1975), pp 71-110.

95168D Tobler, R. L., Read, D. T., and Reed, R. P., "Fatigue Resistance and Fracture Toughness of Engineering Materials at Cryogenic Temperatures", Technical Report, NBS (October 1975), pp 111-150.

95168E Sparks, L. L., "Magnetothermal Conductivity", Technical Report, NBS (October 1975), pp 151-170.

95168F Hust, J. G., "Thermal Conductivity", Technical Report, NBS (October 1975), pp 171-186.

95168G Logsdon, W. A., Kossowsky, R., Daniel, M. R., and Wells, J. M., "Structural Materials for Cryogenic Applications", Technical Report, Westinghouse Electric Corporation, ARPA Order 2569, CST-8304 (1975).

96682 McRickard, S. B., "Twinning Deformation in Iron at 4 K", Physica Status Solidi, 18 (1), 89-97 (November 1, 1966).

96683 Lismer, R. E., "Properties of Some Alloys and Weld Metal Deposits at Low Temperatures", Welding and Metal Fabrication, 30 (1), 19-27 (January 1962).

96684 Murayama, N., Pense, A. W., and Stout, R. D., "The Fracture Toughness of Cryogenic Steels", Paper F-2 presented at the Cryogenic Engineering - International Cryogenics Materials Joint Conference, Queens University, Kingston, Canada (July 22-25, 1975).

96685 Carman, C. M., and Katlin, J. M., "Plane Strain Fracture Toughness and Mechanical Properties of 5Al-2.5Sn ELI and Commercial Titanium Alloys at Room and Cryogenic Temperatures", ASTM STP 432, 124-144 (1968).

96686 Bucci, R. J., Greene, B. N., and Paris, P. C., "Fatigue Crack Propagation and Fracture Toughness of 5Ni and 9Ni Steels at Cryogenic Temperatures", ASTM STP 536, 206-228 (1973).

96687 Sarno, D. A., Bruner, J. P., and Kampschaefer, G. E., "Fracture Toughness of 5% Nickel Steel Weldments", Welding Journal, 39 (11), 486s-494s (November 1974).

96688 Lismer, R. E., "The Properties of Some Metals and Alloys at Low Temperatures", Journal of the Institute of Metals, 89, 145-161 (1960/1961).

96690 Kelsey, R. A., Wygonik, R. H., and Tenge, P., "Crack Growth and Fracture of Thick 5083-0 Plate Under Liquefied Natural Gas Ship Spectrum Loading", ASTM ATP 579, 44-79 (1975).

96691 Person, N. L., and Wolfer, G. C., "Fatigue Crack Growth Rate of Thick 5083-0 Plate at Room and Low Temperatures", ASTM STP 579, 80-95 (1975).

96694 Zinkham, R. E., and Ashton, R. F., "Strength and Fracture of 5083-0 Aluminum Weldments", ASTM STP 579, 159-175 (1975).

96699 Tobler, R. L., Mikesell, R. P., Burcholz, R. L., and Reed, R. P., "Low Temperature Fracture Behavior of Iron-Nickel Alloy Steels", ASTM STP 579, 261-287 (1975).

96700 Nachtigall, A. J., "Strain-Cycling Fatigue Behavior of Ten Structural Metals Tested in Liquid Helium, Liquid Nitrogen, and Ambient Air", ASTM STP 579, 378-396 (1975).

96871 Efferson, K. R., and Leonard, W. J., "Magnetic Properties of Some Structural Materials Used in Cryogenic Applications", Report ORNL-4150, Oak Ridge National Lab, Contract W-7405-ENG-26 (September 1967).

96872 Choy, C. L., Salinger, G. L., and Chiang, Y. C., "Thermal Conductivity of Some Amorphous Polymers Below 4 K", Journal of Applied Physics, 41 (2), 597-603 (February 1970).

96873 Bowers, R., "Magnetic Susceptibility of Copper Metal at Low Temperatures", Physical Review, 102 (6), 1486-1488 (June 15, 1956).

96874 Collings, E. W., Hedgcock, F. T., et al, "Magnetic and Electrical Properties of Some Ternary Mg-Mn-Al Alloys at Low Temperatures", Philosophical Magazine, Series 8, 10 (103), 159-167 (July 1964).

96875 Linz, R. J., Bouley, A. C., Klatfky, R. W., et al, "The Electrical and Thermal Conductivities of Cu-4, 10, and 20 At. % Ni from 1-25 K", IEEE Transactions on Magnetics, MAG-11 (2), 305-308 (March 1975).

96876 Morin, F. J., Maita, J. P., Williams, H. J., et al, "Heat Capacity Evidence for a Large Degree of Superconductivity in V_3Ga in High Magnetic Fields", Physical Review Letters, 8 (7), 275-277 (April 1, 1962).

96877 Fulkerson, W., Moore, J. P., and McElroy, D. L., "Comparison of the Thermal Conductivity, Electrical Resistivity, and Seebeck Coefficient of a High-Purity Iron and an Armco Iron to 1000 C", Journal of Applied Physics, 37 (7), 2639-2653 (June 1966).

96878 Vold, C. L., and Richards, L. E., "Low Temperature Thermal Expansion of A-15 Vanadium-Gallium Alloys", Materials Research Bulletin, 9 (2), 83-88 (February 1974).

96879 Golovashkin, A. I., Levchenko, I. S., Leskova, T. A., et al, "Optical and Electrical Properties of Cast, Superconducting Alloys of Vanadium-Gallium", Physics of Metals and Metallography, 36 (6), 56-65 (1973).

96880 Reese, W., "Low-Temperature Thermal Conductivity of Amorphous Polymers: Polystyrene and Polymethylmethacrylate", Journal of Applied Physics, 37 (2), 864-868 (February 1966).

96881 Reese, W., and Tucker, J. E., "Thermal Conductivity and Specific Heat of Some Polymers Between 4.5 K and 1 K", Journal of Chemical Physics, 43 (1), 105-114 (July 1, 1965).

96882 Reese, W., Higgins, P. J., and Rostine, G. W., "Effects of Radiation-Induced Cross-Links on the Low-Temperature Thermal Properties of Polystyrene", Journal of Applied Physics, 39 (3), 1800-1802 (February 15, 1968).

96883 McCammon, R. D., and Saba, R. G., "Dielectric Properties of Polystyrene and Some Polychlorostyrenes from 4 K to Room Temperature", Journal of Polymer Science, Part A-2, 7, 1721-1733 (1969).

96884 Gupta, K. P., Cheng, C. H., and Beck, P. A., "Low-Temperature Specific Heat of F.C.C. Alloys of 3d-Transition Elements", Journal of Physics and Chemistry of Solids, 25, 73-83 (1964).

96885 Hust, J. G., Weitzel, D. H., and Powell, R. L., "THermal Conductivity, Electrical Resistivity, and Thermopower of Aerospace Alloys from 4 to 300 K", Journal of Research of the National Bureau of Standards, Applied Physics and Chemistry, 75A (4), 269-277 (July-August 1971).

96886 Meaden, G. T., Electrical Resistance of Metals, Plenum Press, New York (1965).

96887 Fickett, F. R., "A Preliminary Investigation of the Behavior of High Purity Copper in High Magnetic Fields", Annual Report, INCRA Project No. 186, NBS, International Copper Research Association (June 1972).

96888 Reed, R. P., Ledbetter, H. M., and Van Reuth, E. C., "Materials Research in Support of Superconducting Machinery-V", Fifth Semi-Annual Technical Report, National Bureau of Standards (April 1976).

96889 Galstan, G. N., "Effects of Polymer Chain Orientation Upon the Thermal Conductivity of Polymethyl Methacrylate at Liquid Nitrogen Temperatures", Doctoral Thesis, U. S. Naval Postgraduate School (May 1966).

96890 Hurd, C. M., "Low Temperature Magnetic Susceptibility of Pyrex, Fused Quartz, and Polytetrafluoroethylene", Review of Scientific Instruments, 37 (4), 515-516 (April 1966).